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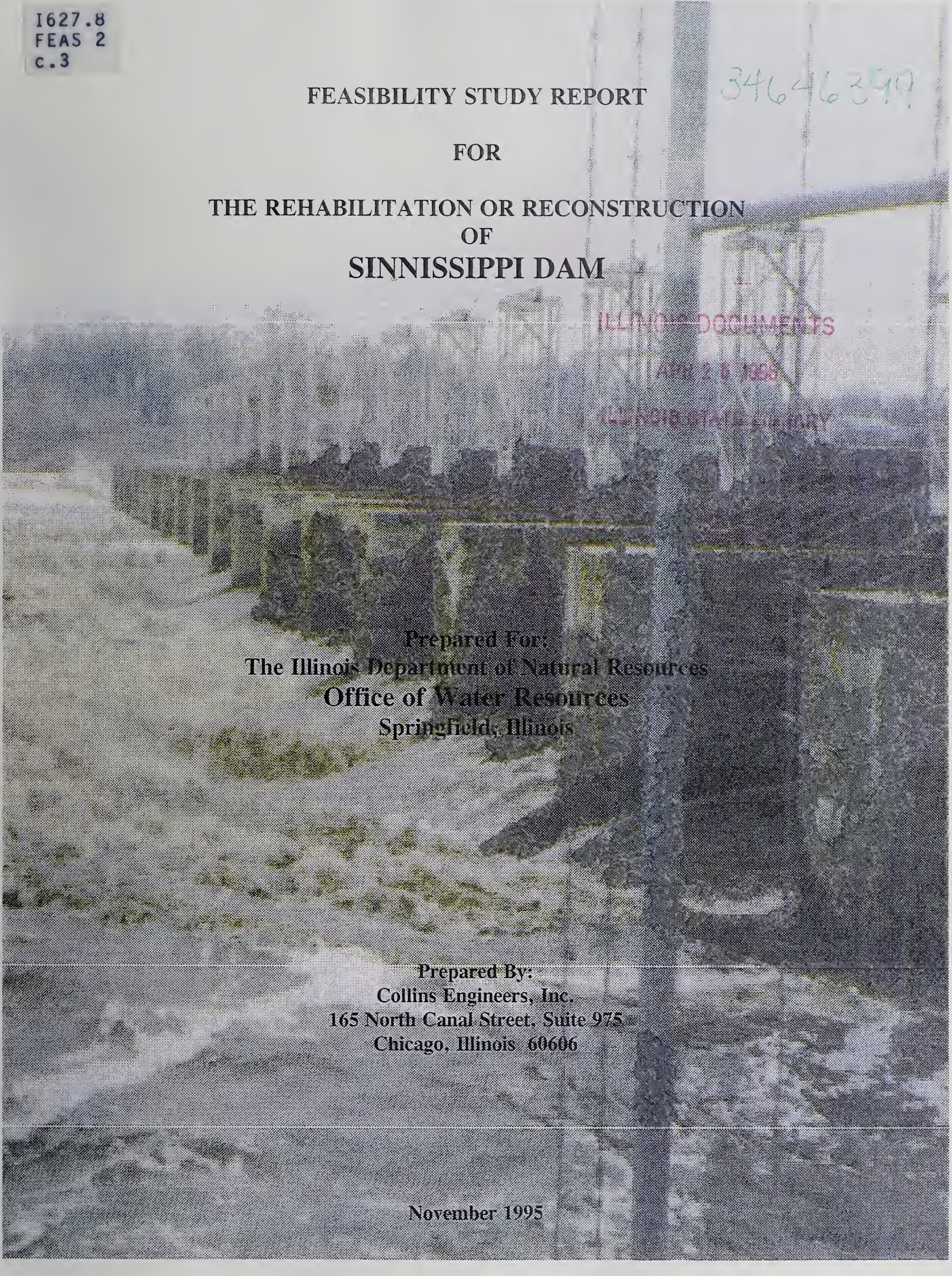

FEASIBILITY STUDY REPORT
FOR
THE REHABILITATION OR RECONSTRUCTION
OF
SINNISSIPPI DAM

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Prepared For:
The Illinois Department of Natural Resources
Office of Water Resources
Springfield, Illinois

Prepared By:
Collins Engineers, Inc.
165 North Canal Street, Suite 975
Chicago, Illinois 60606

November 1995

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Feasibility Study Report
for the Rehabilitation or Reconstruction of
Sinnissippi Dam

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This feasibility study report has been prepared as part of a continuing effort to identify and evaluate the most cost effective long-term solution to the deteriorating condition of the Sinnissippi Dam. Two earlier feasibility studies were performed, at the request of the Illinois Department of Transportation, Division of Water Resources, in 1988 by the U.S. Army Corps of Engineers and in 1991 by Woodward-Clyde Consultants. Each of these studies provided good information but were incomplete in various aspects. This latest study is intended to answer questions remaining from the previous studies and identify the best course of action for the rehabilitation or reconstruction of the dam.

The dam was constructed in 1907 on the Rock River between the cities of Rock Falls and Sterling, Illinois. The original facilities, from left to right looking downstream, consisted of a navigation lock, a spillway consisting of 18 radial gates (10'H x 21'W), 588 feet of a fixed-crest overflow section with flashboards, and a hydroelectric powerplant (added in 1914). The present facilities consist of the original gated spillway and overflow section, along with a 2-MW hydroelectric station (commissioned in 1988) at the location of the original navigation lock and the old powerplant, abandoned with the superstructure demolished and the substructure filled with soil and rock. The project has experienced severe winter operational problems with the gated spillway, with cold winter temperatures and age being the primary causes of deterioration of the facilities.

The 1988 study evaluated five rehabilitation/replacement alternatives. Four of the alternatives consisted of various configurations of fixed crest dams, with and without flashboards. The fifth alternative consisted of rehabilitating the existing facilities. The study concluded with the recommendation of rehabilitating the existing facilities and, therefore, continue to live with the winter operational problems.

The 1991 study considered eleven alternatives; evaluated six of those alternatives with respect to warm weather hydraulic performance; and evaluated four of those alternatives with respect to economic performance. Three of the alternatives consisted of replacing the existing radial gates with hydraulic cylinder operated hinged-leaf gates in association with various configurations of overflow sections, with and without flashboards. The study concluded that the existing radial gates should be replaced with hydraulic cylinder operated hinged-leaf gates. In addition, the study also concluded that the existing concrete-capped timber crib dam (crib dam) should be rehabilitated to extend its life through the next 20 years..

Both the 1988 and 1991 studies qualitatively considered the ice conditions at the dam and on the Rock River in general as problematic, however, specific remedies were not proposed or discussed. Consideration of winter operation conditions has been a primary focus of this latest feasibility study.

The present study began in the winter of 1994 at the direction of the Office of Water Resources, prior to the execution of an engineering services agreement, in order to collect ice thickness and spring ice break-up data. The temperature conditions during 1994 approached those of the coldest on record. Ice thicknesses on the reservoir averaged over 15 inches. A sudden thaw and flood occurred which resulted in an early break-up and passing of a very thick ice sheet, which could be considered as a design condition for the proposed reconstructed facilities. Ice flows as large as 15 feet square and 9 inches thick were passed through the radial gate spillway. During this event, the authors of this report and the Sinnissippi Dam operator witnessed conditions which caused significant damage to the existing radial gates.

The original scope of this study was limited to the gated spillway section only. Various preliminary gated spillway configurations were evaluated technically and financially to confirm the most cost-effective solution with respect to life-cycle costs. A primary requirement of any new facility is the automatic operation of the gates to maintain desired water surface elevations; the operation of the hydroelectric plant can be incorporated into the gate operation plan. Pneumatically operated hinged-leaf gates proved to be the most economical alternative for the replacement of the existing gated spillway (newer technology not considered in earlier studies). Hydraulic cylinder operated hinged-leaf gates were the second most economical. Both of these spillway configurations can be operated very successfully in winter and ice sheet break-up conditions. The environmental effect of the hinged-leaf gate's ability to readily pass ice during break-up and discourage ice formation on the gates over the winter, was evaluated. Sediment transport received special consideration and gate sizes were selected in order to allow operation such that the sediment transport regime in the vicinity of the dam is not significantly altered. The gated spillway section replacement construction costs were estimated to be approximately $3,300,000.

During the course of the study, it became apparent that the overflow section of the dam should be included in the study. Six additional configurations of dams were evaluated. These alternatives consisted of a pneumatically operated or hydraulic cylinder operated hinged-leaf gated spillway with various combinations of an overflow section of either conventional or roller compacted concrete, and with or without demolition of the right bank powerhouse ruins. The City of Rock Falls and their hydroelectric plant operation will derive significant benefits from the elimination of flashboards on the overflow section of dam that could cover a significant portion of the anticipated construction cost.

The conclusion of this study is that both the gated and overflow sections of Sinnissippi Dam should be reconstructed by installing pneumatically operated hinged-leaf gates, constructing a conventional mass concrete ogee spillway, and constructing a jet-grouted cut-off wall through the existing right bank powerhouse's ruins to provide a positive seepage cut-off (Final Alternative 2, as presented in Section 6.2.2). The total estimated construction cost is approximately $6,137,000, with benefits to the City of Rock Falls of approximately $630,000. The reconstruction should be carried-out as soon as possible (on a non-emergency) basis as the condition of the dam is continuing to deteriorate, and also to avoid future gate operation problems

associated with ice, such as those experienced in the winter of 1994. Construction should be phased over a two-year period, with the gated spillway being constructed first in two phases followed by the overflow section being constructed in a single phase during the second year. The construction in each phase should be planned to occur in the May through January time period, in order to minimize control of water and cofferdamming costs.

Respectfully submitted,

W. Robert Ivarson Jr.

W. Robert Ivarson, Jr., P.E.

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1.0 INTRODUCTION

Collins Engineers, Inc. (CEI) was retained by the Illinois Department of Natural Resources, Office of Water Resources (successor to the Illinois Department of Transportation, Division of Water Resources) to perform an Engineering Feasibility Study for the rehabilitation or reconstruction of the existing gated spillway and fixed-crest overflow section at Sinnissippi Dam. Services were performed in accordance with the two Agreements for Consulting Services dated May 23, 1994 and April 28, 1995. The Sinnissippi Dam is located on the Rock River at rivermile 73.6, between the cities of Sterling and Rock Falls, Illinois (see Figure 1 at the end of this section for a location map). The dam consists of a 588-foot long overflow fixed-crest spillway and gated spillway consisting of 18 steel radial (Tainter) gates used for maintaining a constant pool elevation upstream of the dam. A relatively new hydroelectric plant is located at the south abutment wall and the substructure of a decommissioned hydroelectric plant is located at the north abutment. A general plan of the existing structures/conditions at the site is shown on Figure 2 (at the end of this section).

The Feasibility Study was performed according to the Scopes of Work defined in the Agreements for Consulting Services and subsequent meetings and conversations with OWR personnel. Work for the Feasibility Study was performed by CEI and a subconsultant. The subconsultant, Cochran and Wilken, Inc. of Springfield, Illinois performed Task 3 of the Scope of Services.

This study was originally intended for the evaluation of rehabilitation or reconstruction of only the gated spillway section at Sinnissippi Dam. However, after different alternatives for replacing the gates were developed, a meeting was held with OWR officials in August, 1994 in which CEI was directed to incorporate reconstruction of the existing fixed-crest crib dam into the scope of this study. In addition, it was decided that only two of the original gate replacement alternatives be pursued further. Hence, the following alternatives were developed for final evaluation:

1. Pneumatically operated hinged-leaf gates with conventional concrete fixed-crest overflow section (crest El. 636) along with removal of the existing right bank abandoned powerhouse substructure.

2. Pneumatically operated hinged-leaf gates with conventional concrete fixed-crest overflow section (crest El. 636) along with jet grouting of the existing right bank abandoned powerhouse substructure.

3. Pneumatically operated hinged-leaf gates with roller compacted concrete fixed-crest overflow section (crest El. 636) along with removal of the existing right bank abandoned powerhouse substructure.

4. Hydraulic cylinder operated hinged-leaf gates with conventional concrete fixed-crest overflow section (crest El. 636) along with removal of the existing right bank abandoned powerhouse substructure.

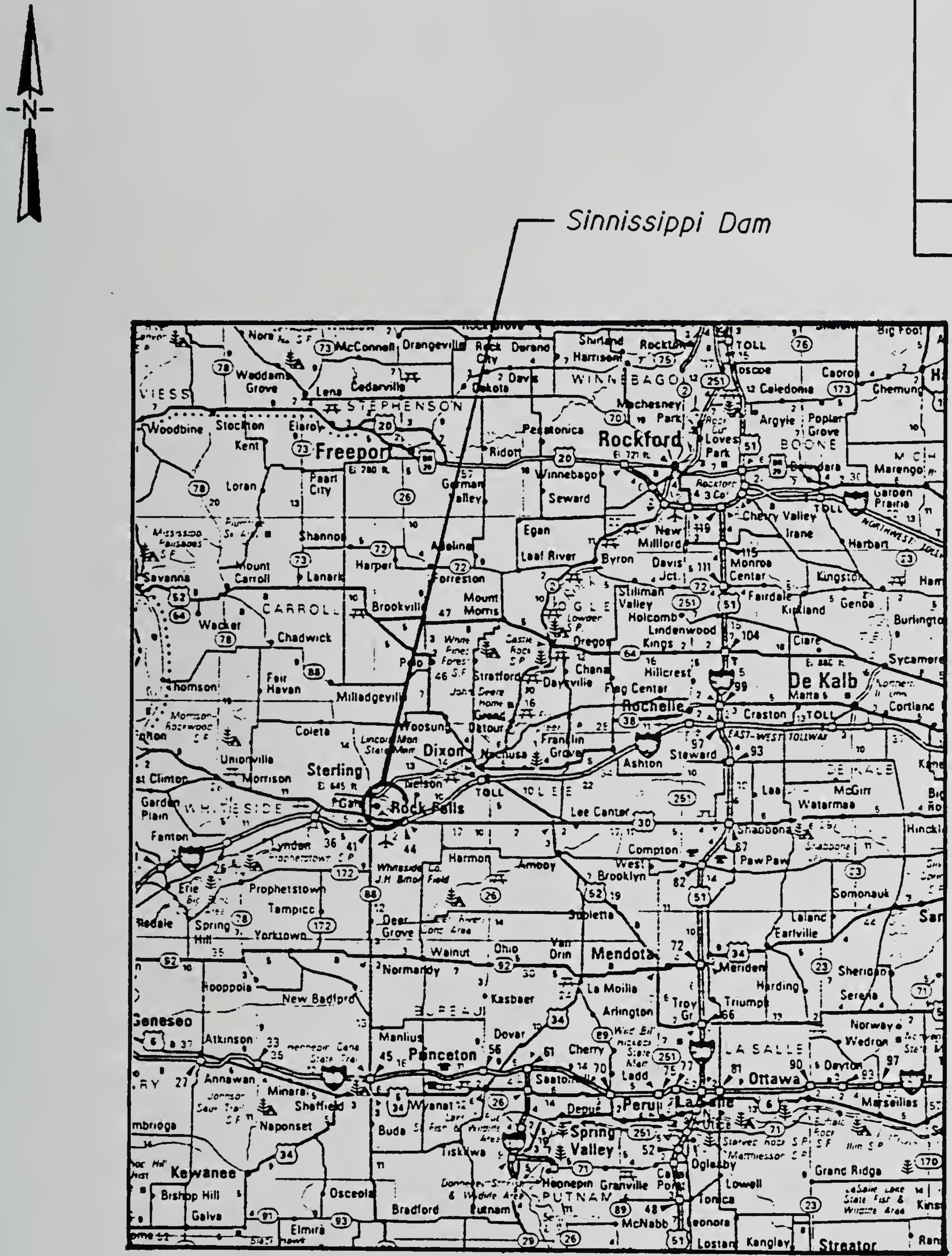
5. Hydraulic cylinder operated hinged-leaf gates with conventional concrete fixed-crest overflow section (crest El. 636) along with jet grouting of the existing right bank abandoned powerhouse substructure.

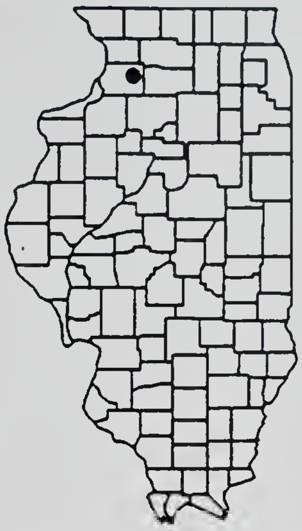
6. Hydraulic cylinder operated hinged-leaf gates with roller compacted concrete fixed-crest overflow section (crest El. 636) along with removal of the existing right bank abandoned powerhouse substructure.

All of the above alternatives were developed after it was determined that it would be more cost-effective not to remove the existing fixed-crest overflow section (crib dam) and rather use it to serve as the upstream cofferdam for the new construction.

This report summarizes the analyses conducted and results of the feasibility study and presents our conclusions and recommendations. The report has been organized in ten sections. Section 2.0 presents the purpose for conducting this study and the scope and objectives of the work performed. Section 3.0 identifies current conditions of the dam and

the dam’s history. This section also presents history of the dam's maintenance. Section 4.0 summarizes the available dam data and reports, and previous studies related to the dam. Section 5 describes the environmental conditions existing at the site. Section 6 describes the different alternatives considered under the original Scope of Services that only included the replacement of the existing gates. The final alternatives evaluated for the replacement of the gated section as well as the fixed-crest section under the revised Scope of Services are also presented in Section 6. The life cycle cost estimates of all the alternatives are presented in Section 7. Section 8 describes the operation and maintenance considerations. Conclusions and recommendations are presented in Section 9. Section 10 lists the references used in the preparation of this report. Sections 11 and 12 contain the drawings for the preliminary and final alternatives, respectively.





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CHICAGO, IL. 60606

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REPLACEMENT

LOCATION MAP

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIGURE 1

11/1/95 PRH

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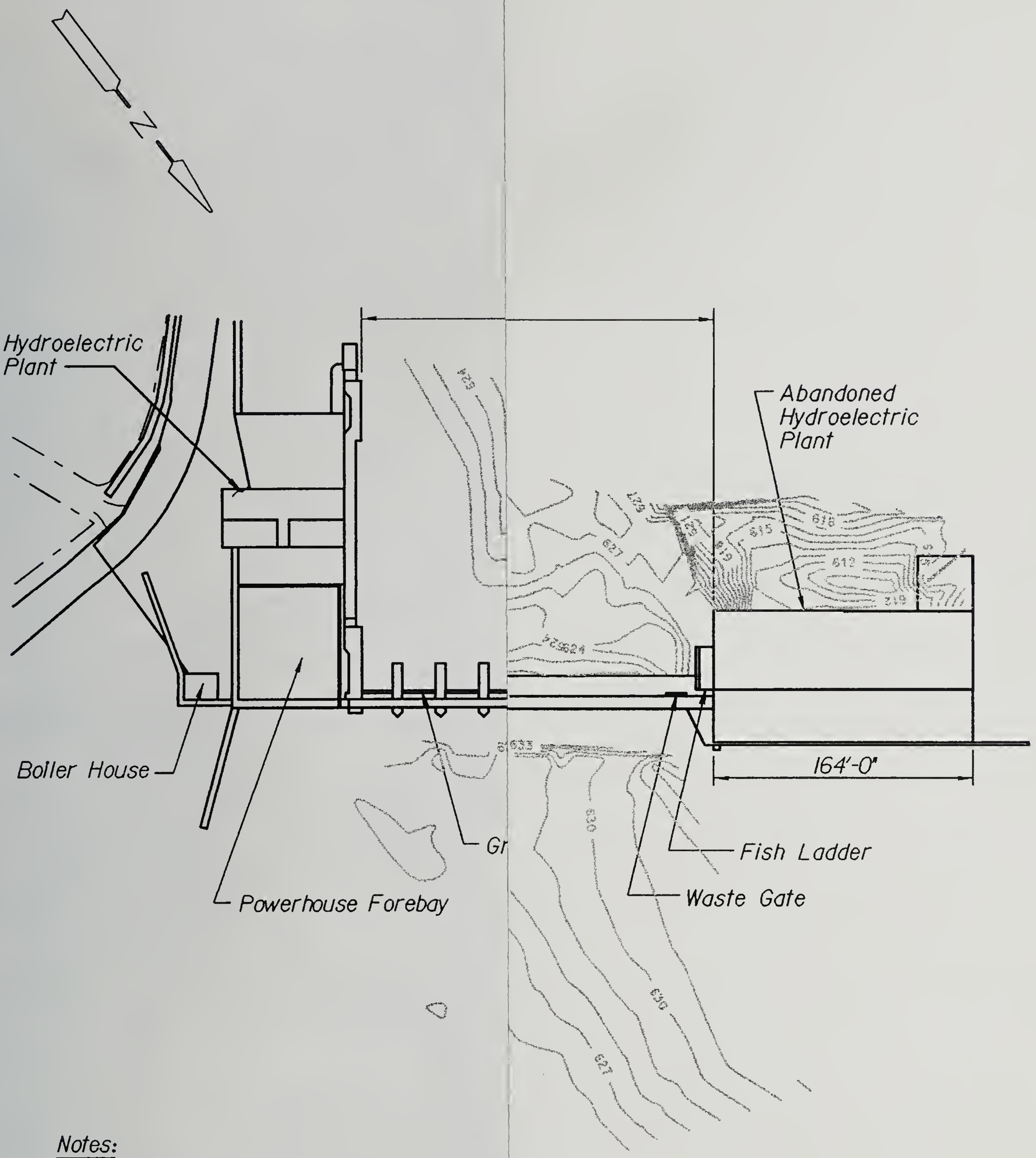

Notes:

1. Survey information and dimensions of existing structures obtained from U.S. Army Corps of Engineers, "Sinnissip Dam Major Rehabilitation Feasibilty Report", August, 1988.

2. River bottom contours developed from hydrographic survey conducted by Collins Engineers, Inc. in July, 1994 and June, 1995.

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

EXISTING CONDITIONS

PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIGURE 2

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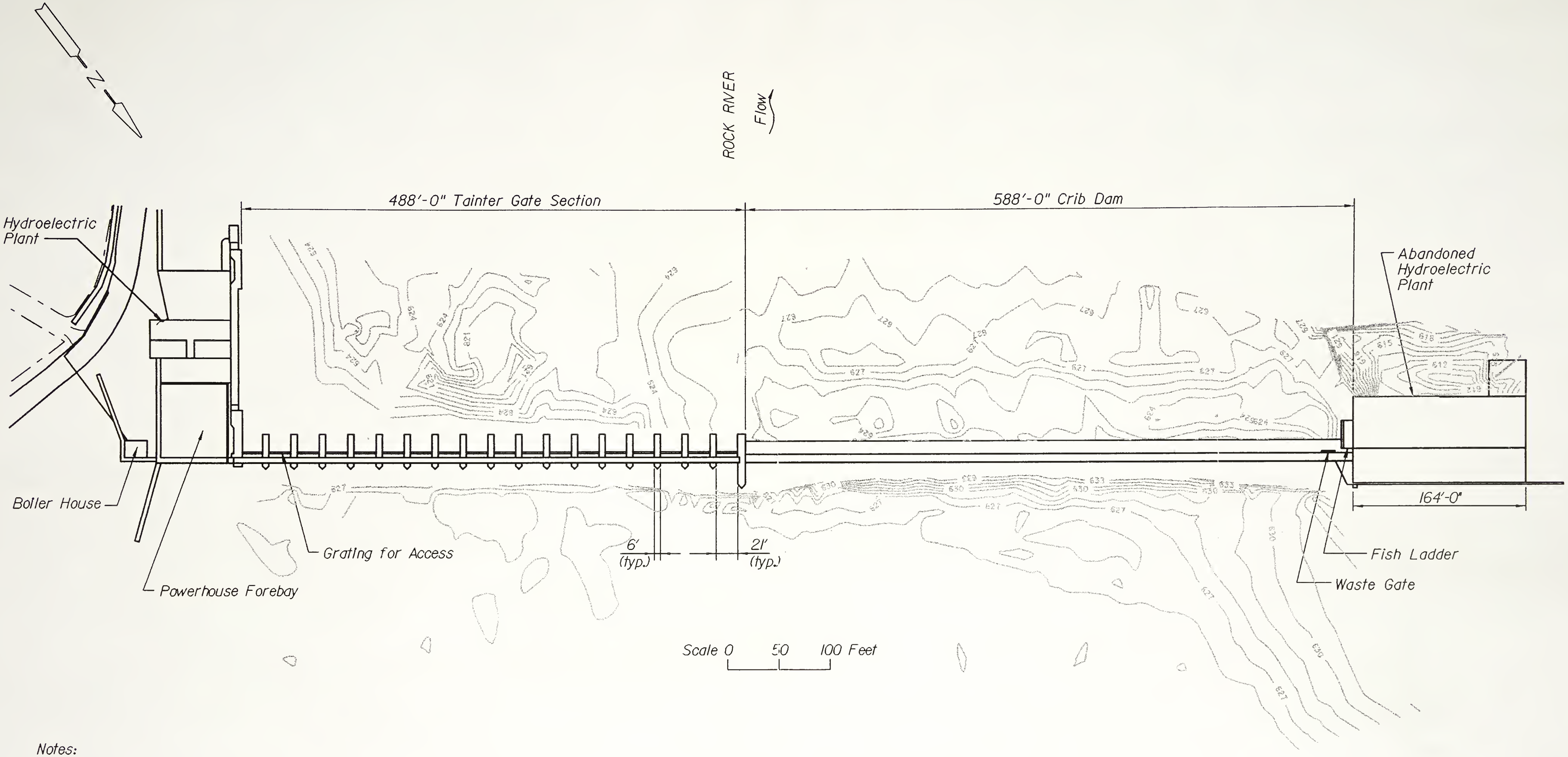

Notes:

1. Survey information and dimensions of existing structures obtained from U.S. Army Corps of Engineers, "Sinnissippi Dam Major Rehabilitation Feasibility Report", August, 1988.
2. River bottom contours developed from hydrographic survey conducted by Collins Engineers, Inc. in July, 1994 and June, 1995.

COLLINS ENGINEERS, INC. 165 N. CANAL ST. CHICAGO, IL. 60606	ILLINOIS DEPARTMENT OF NATURAL RESOURCES SINNISIPPI DAM REPLACEMENT
	EXISTING CONDITIONS PLAN
	DRAWN BY: PRH CHECKED BY: QF
	DATE: AUGUST, 1995 FIGURE 2

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2.0 PURPOSE AND SCOPE OF THE FEASIBILITY STUDY

2.1 Purpose

The purpose of this feasibility study is to identify and evaluate feasible alternatives for Sinnissippi dam that provide a long-term solution to problems associated with the general deteriorating condition of the dam and with the operation of the existing gates in winter ice conditions. This study identifies the most economical and efficient alternative among the selected feasible alternatives. The feasibility study addresses:

1. Review the feasibility studies prepared by the U.S. Army Corps of Engineers (COE), Rock Island District, dated August 1988 and by Woodward-Clyde Consultants (WCC), dated February 1991.

2. Identify design alternatives that are cost-effective, provide fully automated and easy operation during winter and other operating conditions, and that do not significantly alter the current hydraulic and sediment transport regime.

3. Determine the cost savings to the City of Rock Falls associated with the elimination of flashboards from the fixed-crest spillway alternatives.

4. Perform life-cycle cost analyses for all of the alternatives evaluated. Select the best alternative based on total initial capital expenditure and the present value of the future maintenance costs over the life of the project. In the selection of the best alternative, considerations should also be given to the suitability of the alternative to the overall objectives of the project.

2.2 Scope of Work

The Scope of Work included the following individual task items that formed the two Agreements for Consulting Services, dated May 23, 1994 and April 28, 1995:

Task 1

An ice survey will be made of existing conditions upstream of the project to Dixon Dam and downstream to the lower dam. This survey will begin before the contract is in place as discussed in the January 26, 1994 meeting. The survey will consist of as many as 3 site visits and phone interviews with former IDOT/DWR dam operators. Brief trip reports will be written for each site visit and phone logs will be written for interviews.

Task 2

Existing reports and data regarding Sinnissippi Dam will be reviewed. This will include the two previous feasibility reports as well as dam operational records and applicable environmental data in the files of IDOT/DWR, USACE, and IDOC. Based on preliminary discussions with the Illinois Department of Conservation, there is a substantial amount of existing environmental information regarding the operation of this existing Rock River dam and the new hydroelectric facilities. This information will be researched and reviewed. Environmental impact issues and the current dam and hydroelectric plant operation regime agreements will be reviewed. The intent of the proposed replacement of the spillway gates project is to maintain the present pool and spillway operational regime, however, the new gates may pass higher ice flows during surface freeze up and spring ice break-up conditions. The environmental impacts of this possible situation will be analyzed in consultation with IDOC and IDOT staff.

Task 3

Impacted habitat site visit will be made of the area to be potentially impacted by a changed ice/flow regime on the left bank both upstream and downstream of the spillway. This survey will include interviews with IDOT/DWR, IDOC and City of Rock Falls personnel.

Task 4

A hydrographic survey will be made of the lake and channel bottom in the area of the spillway within 200 feet of the spillway. A hydrographic map will be produced with a one foot contour interval. Hydrographic data will be used to evaluate spillway hydraulic performance and the potential use of bubblers for ice suppression at the spillway gates.

Task 5

A spillway layout drawing will be made for each of four alternatives studied (Tainter gate, over and under Tainter gate, hinged-leaf gate, and rubber dam/gate). A gate control schematic will be developed as well as ice suppression details.

Task 6

A constructability analysis will be made for each of the alternative. This analysis will include construction sequencing, scheduling, cofferdamming as well as future gate maintenance considerations.

Task 7

Data will be collected from similar gate installations in similar environments. We envision discussions with the COE regarding Tainter gates at dams on the Illinois and Mississippi rivers. Manufacturers will be consulted regarding the locations of installations of Over/Under Tainter gates and Rubber Dams. Utilities in the northeast United States will be contacted regarding their experiences with hinged-leaf gates.

Task 8

A life cycle cost analysis will be performed for each of the four alternatives. Spreadsheets will be produced detailing cost items and anticipated cash flow.

Task 9

An ice/flow regime impact analysis to characterize each alternative's performance with respect to passing ice downstream and ice suppression requirements to keep operable and ice-thrust within acceptable limits. This task will utilize data collected in Tasks 1, 2, 3, 4, and 7.

Task 10

The selection of the recommended alternative will be based upon the attempt to minimize total cost and minimize potential environmental impacts.

Task 11

A final report will be prepared, describing the study, its findings, and summarizing the action plan for implementing the proposed spillway improvements.

Task 12

The Project Management function will include the coordination and direction of all of the preceding tasks, being the focal point of all project communications, and the preparation of monthly progress reports for the duration of the contract. Two progress meetings are scheduled in Springfield at the conclusion of Task 9 and after review of a draft final report, and are included in this task.

Task 13

Develop Alternative 6, Hybrid of Bascule and Steel Radial Gates for replacing the existing gates at Sinnissippi Dam. Work includes development of layouts and cost estimate, performing constructability analysis, ice/flow regime impact analysis, and life-cycle cost analysis.

Task 14

Study the possibility of using either floating or full-span crane-placed bulkheads for maintenance purposes. Work includes the development of layouts and cost estimate.

Task 15

December 7, 1994 meeting/presentation in Springfield. Work includes attending the meeting, preparing for the presentation, and preparation of exhibits for maintenance bulkheads for the two alternatives selected for further investigations.

Task 16

An analysis of various gate failure response scenarios will be made. The following failure modes/scenarios will be considered for the corresponding Bascule Gate alternative and/or the Pneumatic Crest Gate Alternative:

a. Leaks in the air lines.

b. Electrical power outages.

c. Compressor failure.

d. Slow leak in bladder with headwater at Elevation 636.

e. Complete deflation of bladder with headwater at Elevation 636.

The analysis will include probability of failure of the bladders under different conditions based on historical data/performance. In addition, an analysis of lifting the gate by a crane under normal headwater conditions will be made. The analysis will include determining the structural integrity of the gate, and the load carrying capacity of the crane and the overhead bridge. The

possibility of placing struts behind the gates under normal headwater and complete bladder failure conditions will also be explored.

Task 17

Review the previous feasibility reports' sections relating to the existing crib dam's repair and replacement.

Task 18

Survey the area downstream of the crib dam to collect spot riverbed/bedrock elevations. This data combined with the earlier hydrographic survey data will be used to optimize the location of the proposed overflow spillway section and the configuration of the temporary, cofferdams.

Task 19

Layout drawings will be prepared for each of two crib dam replacement alternatives. The following alternatives will be developed after it is determined whether it will be cost beneficial to use the existing spillway as the upstream cofferdam or whether a separate cofferdam will need to be constructed to facilitate construction of the new spillway:

a. Replace the existing crib dam by a concrete ogee section located either along the alignment of the existing dam or located downstream of the existing crib dam, and use the existing crib dam as the upstream cofferdam. (The alignment decision will depend on which upstream cofferdam alternative is recommended.)

b. Replace the existing crib dam by a roller-compacted concrete overflow section located either along the alignment of the existing dam or located downstream of the existing crib dam, and use the existing crib dam as the upstream cofferdam. (The alignment decision will depend on which upstream cofferdam alternative is recommended.)

The development of the above alternatives will include an analysis of replacing the existing overflow/flashboard system by providing the discharge capacity attributed to flashboard washout with additional length of gated section.

Task 20

The above alternatives will be developed by coordinating with the Illinois Department of Conservation and its plans to develop a park on the right bank of the river.

Task 21

Determine the yearly cost savings to the City of Rock Falls associated with not having to replace flashboards every year because of the new fixed crest spillway. The analysis will be made after gathering data about the number of days each year the flashboards are not in place and the manpower employed by the City to install the flashboards. The analysis will include the positive impacts on the powerplant's energy generation due to the elimination of flashboards and automated control of the gates based on water levels and hydropower generator load status. This will be accomplished by estimating the amount of additional energy generated (kWh) per year due to the fixed crest spillway/flashboard elimination.

Task 22

A constructability analysis will be made for each crib dam replacement alternative. This analysis will include construction sequencing, scheduling, cofferdamming, as well as future maintenance considerations.

Task 23

A life-cycle cost analysis will be performed for each of the alternatives. Spreadsheets will be produced detailing cost items and anticipated cash flows.

Task 24

The selection of the recommended alternative will be based upon the attempt to minimize total cost and minimize potential environmental impacts.

Task 25

A final report will be prepared, describing the study, its findings, and summarizing the action plan for implementing the proposed gate and dam improvements.

Task 26

The Project Management function will include the coordination and direction of all of the preceding tasks, being the focal point of all project communications, and the preparation of monthly progress reports for the duration of the contract. (A progress meeting, as mentioned in the original scope's Task 12, will be held in Springfield after review of a draft final report. Please note that the man-hours required for this meeting are not included in this task as they have already been included in the original scope's Task 12, therefore, no additional costs are included for this meeting in this revised scope.)

2.3 Objective and Criteria of the Feasibility Study

The objective of the feasibility study is to identify feasible replacement alternatives that will extend the service life of Sinnissippi Dam by at least 60 years without impacting the current upstream pool or hydraulic and sediment transport conditions that currently exist at the dam. The minimum design criteria are:

1. Provide an equivalent or slightly lower upstream water surface profile that exists under the present dam configuration for all discharges up to the 500-year design flood.

2. Maintain a constant upper pool elevation of 636.0 ft. to:

    - support the recreational activities upstream of the dam,
    - maintain minimum flow conditions and water surface elevation requirements for the Illinois-Mississippi Canal, and
    - avoid negative impacts on powerplant operation.

3. Minimize or, if possible, eliminate problems that currently exist during winter operation of the radial gates.

4. Minimize or limit impact to the Sterling Park District's proposed right bank park development.

5. Minimize gated spillway operational and maintenance activities and their associated costs. This includes the elimination of flashboards on the fixed-crest section. Spillway bay lengths should be chosen so that dewatering of individual bays is facilitated during maintenance operations.

3.0 PROJECT DESCRIPTION AND HISTORY

3.1 Project Description

The Sinnissippi Dam, also called the Upper Rock Falls Dam and Upper Sterling Dam, is located on the Rock River at river mile 73.6, between the cities of Sterling and Rock Falls, Illinois (Figures 1 and 2 in Section 1). The dam consists of a 588-foot long overflow spillway section and a 488-foot long gated spillway section. The overflow spillway section consists of a rock-filled timber crib covered with a 1 ft thick concrete layer for water retention and erosion protection purposes. The overflow spillway is fitted at the top with 28 inches high removable wooden flashboards to maintain the upper pool elevation at 636.0 feet during low flow periods. These flashboards are designed to fail during severe flood conditions. The gated spillway section consists of 18 radial (Tainter) gates, 21 feet wide and 10 feet high, which are operated to maintain a constant upstream pool elevation. The Tainter gates are manually operated by a traveling hoist and counterweight tower system located on a 6-foot wide service bridge. The gates and bridge are supported by concrete piers which along with the dam are founded on bedrock. The piers are 6 feet wide and 34 feet long.

3.2 Project History

The Sinnissippi Dam was constructed by the U.S. Army Corps of Engineers in 1907. The original purpose of the Dam was to divert flow into the Illinois-Mississippi Feeder Canal (as part of the Hennepin Canal), located just upstream of the dam's left (south) abutment. The Dam also creates a navigable pool in the Rock River and provides the hydraulic head needed for hydroelectric power generation.

The Rock River Light and Power Company constructed a hydroelectric power plant adjacent to the right (north) dam abutment in 1914. After years of service, the plant was closed and finally demolished in 1977. The concrete substructure of the plant was then filled with rock and abandoned. Ownership was transferred to the State of

Illinois, Department of Conservation, now known as the Illinois Department of Natural Resources, in 1970. Operation and maintenance of the facility is the responsibility of the Office of Water Resources at the Illinois Department of Natural Resources. A new hydroelectric powerplant was constructed in the abandoned navigation lock adjacent to the left (south) dam abutment and has been in operation since July 1988.

The Illinois-Mississippi Feeder Canal is listed on the National Register of Historic Places as part of the Hennepin Canal Historic district. The Rock River is generally considered a scenic and aesthetic resource. The river downstream of the dam provides a popular sport fishery for the Rock Falls-Sterling area.

3.3 History of Dam Maintenance

Limited rehabilitation or maintenance records for the facility were available. The last major rehabilitation of the dam was performed by the IDOT in 1990. This included replacing counterweight chains and shackles, and replacing bottom seals for 15 gates and side seals for 6 gates. In 1962, the COE performed a major rehabilitation consisting of minor concrete resurfacing, rehabilitation of the radial gates, rehabilitation of the crib dam overflow section, and replacement of the radial gate operating machinery. The state has performed maintenance on an "as-needed" basis since 1971.

4.0 AVAILABLE DATA, REPORTS AND STUDIES

CEI reviewed reports and documents supplied by the Office of Water Resources that pertain to Sinnissippi Dam in order to extract information concerning the present project. The bulk of this data was obtained from the Woodward-Clyde Feasibility Report, the COE's Feasibility Report, and other documents related to the Rock Falls Hydroelectric Power Project.

4.1 Woodward-Clyde Consultants (WCC) Feasibility Report

WCC conducted the feasibility study in two stages. The first stage was completed in February 1991, and dealt with identifying and evaluating feasible alternatives that would provide a long-term solution to the deteriorating condition of Sinnissippi Dam. The second stage was an addendum to the first stage feasibility study and covered a site investigation of the crib dam section. The second stage was completed in January 1992. A summary of the WCC feasibility study follows.

The first stage of the WCC feasibility report involved identifying and evaluating alternatives for rehabilitating Sinnissippi Dam. WCC's criteria for identifying and evaluating the alternatives was:

a. Maintain water surface elevation at the dam under low flow conditions at 636 ft.
b. Maintain the existing or slightly lower water surface profiles.
c. Minimize dam maintenance and operation.
d. Develop cost-effective alternatives to extend the life of the dam by 100 years.

The following alternatives were developed:

a. Rehabilitate the existing structures.
b. Replace the existing radial gates with hydraulic cylinder operated hinged-leaf gates (referred to in the WCC report as hinged crest gates) and continue

using the existing crib dam.

c. Replace the existing radial gates with hydraulic cylinder operated hinged-leaf gates and replace the crib dam with an ogee spillway.

d. Replace the existing radial gates with hydraulic cylinder operated hinged-leaf gates and replace the existing crib dam with a labyrinth spillway.

WCC evaluated the alternatives based on minimum cost and recommended Alternative b (above) if the service life of the existing crib dam was greater than or equal to 10 years. If the service life of the existing crib dam was less than 10 years, then they recommended Alternative c .

In the second stage of its study, WCC investigated the crib dam section to evaluate its useful life and identify the structural repairs or modifications necessary to extend the life of the dam for at least 20 years. During its investigation WCC found the following:

- Leakage of water through the upstream pine sheeting of the dam appears to have a minor effect on the dam's performance.

- The upstream concrete cover does not have major cracks, but the downstream cover has at least one major crack that is about 100 feet long, 1.5 inches wide and 6 inches deep.

- Rubble backfill extends approximately 25 feet upstream of the vertical upstream face of the dam.

As part of the crib dam's rehabilitation program, WCC recommended a combination of measures that included repairs, maintenance and surveillance. The measures included providing adequate drainage at the downstream concrete cover, replacing cracked concrete panels, placement of large riprap or grout-filled bags along the downstream face of the dam, and periodic inspections to monitor leakage, displacements and changes in the condition of the concrete.

WCC's final recommendation based on total cost was to install new hinged crest gates in place of the existing gates and to rehabilitate the existing crib dam section as described above.

The WCC feasibility report did not adequately address several issues about their recommended alternative which would preclude it from being considered as the final pre-design phase configuration and solution for the rehabilitation/reconstruction of the Sinnissippi Dam:

1. It would alter the sediment transport regime by having a significantly higher gate sill elevation than that of the existing gates.

2. It would result in slightly higher upstream water surface elevations under certain Rock River flow conditions than do currently exist.

3. Operation and maintenance issues critical to the selection of a particular alternative were not adequately described.

4.2 Corps of Engineers Feasibility Study

The U.S. Army Corps of Engineers conducted the feasibility study in 1988 which included a brief description of the project and its history, a detailed evaluation of the existing dam condition, analysis of dam stability, hydraulic analysis, consideration of several rehabilitation or replacement alternatives and an environmental analysis. A summary of the COE's study is included in the following sections.

4.2.1 Evaluation of Dam Condition

The COE's field investigations included a survey of the piers' concrete condition and inspection of the radial gates and existing machinery. These investigations are summarized below:

Concrete Piers

The field survey of the concrete piers consisted of visual examination and physical sounding of the exposed concrete surfaces with a hammer. Cracks, drummy, spalled and distressed areas were observed and located. Three random 4 in. diameter cores were taken to assess the piers' interior condition and strength.

The COE concluded that all the 18 piers had moderately deteriorated concrete, with numerous large transverse and horizontal cracks, some of which were related to internal reinforcing members. General and localized spalling, up to 2 in. deep, was also observed. All but three of the piers had been repaired on at least one side (generally downstream) in the area of the trunnion beam anchorage. These repairs apparently did not correct the cause of the spalling since the replacement concrete had spalled and deteriorated again. Many of the old repairs in the area of the gate faces were D-cracked , leaching and drumming but none appeared to have immediate structural problems. The upstream noses displayed lift line/cold joints problems. There were also varying degrees of weathering and spalling near the water line on some piers. all counterweights, except one, were cracked and leaching, however, none appeared critically damaged.

Radial Gates

The radial gates were last repaired and painted in 1962. They were visually inspected above the water line and were found to be in fair structural condition. The pickup chains were detached from the dogging device on several gates. These chains were still attached to the gates but were lying on the bottom of the river. The bottom seals on nine of the gates were in poor condition, causing large amounts of leakage to occur under the gates. The side seals were in relatively good condition although there were tight clearances between the gate seals and concrete piers that resulted in frequent binding of the gates. The concrete condition survey indicated some distress in the tainter gate support beam anchorage area. Spalled and cracked concrete

in the vicinity of the anchorage location indicated either nonuniform loading on the beam bearing surface or displacement of the support beam anchorage.

Gate Hoisting Machinery

The overall condition of the gate hoist units was fair to good. The transfer shaft coupling flexible intermediate plates had been a maintenance problem and replacement parts were no longer available. The reducer gearbox had leaked oil through its seals. The motor, brake, and bearings were all visibly in good working condition. The chain drums were in good condition but were too small in diameter to wrap the entire chain. Based on the COE's evaluation they also did not meet design criteria for bending stresses in the chain when wrapped. The unit showed areas of minor to moderate corrosion with considerable paint loss.

Service Bridge

The service bridge support beams, grating and handrails were in good condition. Minor areas of corrosion were noted, but not found to be significant. It was noted that the location of the support beams would interfere with placement of a bulkhead in the upstream slots of each gate.

Radial Gate Upstream Bulkhead

The condition of the sill timber was unknown and diver inspection of each sill was recommended prior to any bulkhead placement. Timber bulkheads were used for the 1962 construction work on the dam.

4.2.2 Dam Stability and Hydraulic Considerations

A stability analysis was performed on the radial gate and crib dam overflow sections. The radial gate piers were analyzed under normal water conditions and with an ice loading. The gate sills were analyzed using normal water levels with the gate in place and both normal and low tailwater levels with the bulkhead in place. Anchor rod stresses were analyzed where applicable.

Analysis of the crib dam was completed using normal water levels. According to these analyses, the existing dam met the required criteria and stresses for sliding and overturning.

The hydraulic analysis included calculation of the river flood profiles for 2, 5, 10, 25, 50, 100 and 500 year frequencies. The existing flood profiles and discharge rating curves were used as a baseline to compare the alternatives studied. The optimum point for alternative comparison was to provide the same discharge capacity as the existing dam for a variety of headwater conditions.

4.2.3 Alternatives Considered

The COE's feasibility study consisted of two parts; namely, a preliminary study of five alternatives, and a further study of the more feasible alternatives. The preliminary part of the study focused on five alternatives including: A) complete replacement of the facility with a fixed crest crib dam without flashboards, B) a fixed crest crib dam with flashboards, C) a fixed crest ogee spillway with flashboards, D) replacement of the gate section and abandoned powerhouse with an ogee crest spillway with flashboards, and E) rehabilitation of the existing facility. Each alternative was evaluated with respect to three criteria for conducting the feasibility study. The criteria included a long-term economical solution, a sufficient upper pool elevation and minimum operation and maintenance of the alternative.

The preliminary analysis indicated that alternatives A, B and C were impractical to implement and did not warrant further study. Alternatives D and E were carried forward to determine the impacts and costs of implementing such alternatives. Alternative D consisted of replacing the gated section of the dam and abandoned powerhouse with a fixed crest ogee spillway. The work items recommended under alternative E were major rehabilitation of concrete, tainter gates, service bridge, dam machinery and

tainter gate bulkheads. While the total cost for alternative D was considerably higher than alternative E, each alternative had attractive and unattractive characteristics.

4.3 Review of U.S. Army Corps of Engineers' Hydraulic Model

The Corps of Engineers' hydraulic model was briefly reviewed and found to be acceptable. The design flows used by the Corps of Engineers for the 2, 5, 10, 25, 50, 100 and 500 year recurrence interval discharges were developed based on streamflow data taken from a USGS gaging station at Como, Illinois. The station is located on the Rock River about 4.4 miles downstream of the Sinnissippi Dam. Streamflow data from the Como gage and resulting design flows appear reasonable. It is our understanding that frequent ice-jams and ice-jam breaks occur between the Dam and the Como gage and as such the peak flows recorded at the gage may be somewhat higher than actually experienced at the dam. The design flows estimated by the Corps of Engineers range from about 24,500 cfs to 72,200 cfs for the 2 and 500 year floods, respectively. The flood discharge frequencies adopted in this study are shown in Table 4.1.

CEI developed a preliminary discharge-rating curve for the dam's existing conditions to check the accuracy of the COE curve. Some differences were observed between the two curves, which are attributed to the COE not taking into account tailwater effects at the gates and at the fixed-crest section (the CEI curve is presented in Figure 8.1 at the end of Section 8). However, the general methodology and results of the COE hydraulic model were deemed to be satisfactory. Hence, for purposes of this study, the hydrologic/hydraulic analysis and model development used by the Corps of Engineers was used as the basis for development and evaluation of feasible alternatives for Sinnissippi Dam.

4.4 Environmental Information

An environmental report was prepared by Stanley Consultants, Inc. as part of an application for exemption from licensing requirements for the Sinnissippi Dam Hydroelectric Power Project constructed within the navigation lock at the south end of the dam. The construction of this project diverted river flow, temporarily disrupted aquatic life in the construction zone, and caused temporary siltation impacts on the river. The recommended replacement alternative for Sinnissippi Dam may have similar impacts on river life. The hydroelectric power project had the following temporary environmental impacts:

- Lost vegetation such as trees and brush;
- Fish losses caused by cofferdam construction and loss of habitat;
- Mussel losses caused by cofferdam construction and dewatering operations;
- Temporary loss of aquatic habitat beneath and within the area of cofferdam;
- Siltation impacts during cofferdam construction;
- Temporarily spurred economy;
- Disruption of traffic by heavy machinery;
- Temporary loss of fishing access in construction zone;
- Improved historical area exhibits and general improvement to aesthetics; and
- Construction noise.

The Corps of Engineers studied the environmental impact of dam rehabilitation

including impact on water quality and aquatic ecosystem. The COE predicted no adverse permanent effects from the rehabilitation option (Alternative E of its Feasibility study).

The environmental report by Stanley Consultants included information from the State Historic Preservation Officer (HPO) regarding the historical importance of the dam. The HPO concluded that the boundaries for the Hennepin Canal Historic District "terminate at the junction of the feeder canal and the Rock River" and do not include the dam (letter from David Kenney, State Historic Preservation Officer, dated 26 January 1982).

4.5 Geologic Information Review

The "Final Report, Subsurface Exploration for the Rock Falls Hydroelectric Project" by Engineers International, Inc. dated May 1986, reviewed the on-site geology based on soil and rock borings. This report contains information regarding the physical condition of the Silurian dolomite upon which the dam is built. The following information was obtained which would be useful in the design/rehabilitation of Sinnissippi dam.

- The bedrock immediately under the dam is dolomitic limestone with shale partings and numerous broken and weathered zones with voids and minor solution channels;
- Weathered zones and clay partings reduce the compressive strength, and tensile strength of the bedrock;
- A jointing survey identified two sets of near-vertical joints, some of which were re-healed with calcite and pyrite;
- Rock quality designation (RQD) as a function of depth suggested that the dam was underlain by interbedded competent and less competent rock units; and

- Grouting was recommended to plug solution voids and prevent water infiltration underneath the cofferdam.

TABLE 4.1

ESTIMATED FLOOD DISCHARGE FREQUENCIES

Recurrence Interval (yr)	Rock River Discharge at Sinnissippi Dam* (cfs)
2	24,500
5	35,300
10	42,000
25	49,900
50	55,500
100	60,800
500	72,200

*These discharges were estimated by the Corps of Engineers based on streamflow data taken from the USGS gaging station at Como, Illinois (COE Feasibility Report, August 1988).

5.0 SITE ENVIRONMENTAL CONDITIONS

5.1 Climactic Extremes

Climatic conditions at the site are characterized by very cold and long winters to hot but relatively short summers. Normal temperatures in the region range from a low of 14°F in January to a high of 83°F in July. The winter of 1993-1994 was especially cold with several periods of temperatures remaining significantly below normal for many days at a time. A graph of normal high and low temperatures, and the daily high and low temperatures recorded between November 1993 and March 1994 at Chicago's O'Hare Airport (approximately 130 miles east of the project site) is presented on Figure 5.1.

Severe gate operation problems were experienced during January and February of 1994. The problems were caused by the formation of a thick (sheet) layer of ice in the reservoir upstream of the dam. The ice had bonded to the (upstream) skin plates of several gates because of which the gates could not be raised to either allow water to be discharged through them, or to pass ice through them. Some of the gates and piers were also severely damaged because of those conditions.

5.2 Geologic Conditions

Geomorphic conditions at the site were studied by reviewing the May 1986 report by Engineers International, Inc. titled "Final Report, Subsurface Exploration for the Rockfalls Hydroelectric Project". The conclusions reached in that report are presented in Section 4.5.

5.3 Geomorphic Conditions

Sediment transport in Illinois streams has been the subject of two excellent studies in the past 12 years. USGS Report 83-4136, titled Measurement of Bedload Discharge in Nine Illinois Streams with the Helley-Smith Sampler , described

bedload transport on the Rock River near Joslin, Illinois, and included a bedload rating curve. Report WRIR 83-4136 concluded that the bedload discharge data collected correlated well with theoretical estimates using Einstein's, Schoklitsch's, and Meyer-Peter, Muller's methods. Illinois Department of Energy and Natural Resources Report of Investigation 106, titled Sediment loads of Illinois Streams and Rivers , described suspended sediment discharge on the Rock River at Rockton, Illinois and near Joslin, Illinois. Report ISWS/RI 106/86 estimated annual suspended sediment loads.

As part of this study, using the data from the above-mentioned previous sediment transport studies and flow duration curves at Sinnissippi Dam, bedload rating curves were transposed from Joslin. Estimates of total annual average bedload and total annual average sediment load were made as 13,000 and 1,350,000 tons per year, respectively. These sediment transport rates indicate that bedload transport in the Rock River is relatively low and that the tributary area surface soils are predominantly silts and clays. Dams on the Rock River do not significantly affect the river's sediment transport regime.

5.4 Terrestrial and Aquatic Environment

An environmental survey was conducted by Cochran and Wilken, Inc. of Springfield, Illinois as part of this feasibility report. They conducted a site investigation and reviewed the available historic environmental information.

Terrestrial wildlife observed during the site inspection included gray squirrels and fox squirrels. Raccoon fecal material was observed along the south shoreline downstream of the powerhouse. A woodchuck den was observed in the same area along the high bank. Species not observed during the site visit, but reported to be present in the area include eastern cottontail rabbits and Norway rats.

Birds observed during the site inspection included mallard ducks, wood ducks, common crow, herring gulls, and great blue heron. Several mallard ducks were

observed feeding on the algae along the overflow spillway. Mallard hens with young were observed in the Sinnissippi Pool and it appears that sufficient duck nesting habitat does exist in the project area. Two great blue herons were feeding in the shallow tailwater areas. Crows and herring gulls were scavenging trash and debris in the park downstream of the powerhouse. The dam operator reported that bald eagles are occasionally seen at the dam during winters. They feed upon fishes which they capture within the open-water area (with no ice cover) downstream of the existing gates. The proposed mode of operation of the new gates, as described in Section 8 of this report, will increase the open-water area downstream of the gates which will improve feeding conditions for the bald eagles. Other songbirds reportedly exist in the area but were not observed during the site inspection.

Fish sampling was not conducted during the site visit. The tailwater areas at both the upper and lower dams do provide a popular sport fishery. Fish species lists compiled in the Application for Exemption from Licensing for the Upper Sterling Dam Hydroelectric Project are included in Tables 5.1 and 5.2. Rock River supports a diverse fishery in this area due to the variety of habitats available. It is likely that the majority of the common species listed in Table 3 still occur in Rock River.

Freshwater mussels including floaters, white heelsplitters, pink heelsplitters, pocketbook and fragile papershell were collected from the project area in 1982. No mussel sampling was conducted during this field inspection, however, floater shells were observed along the bank downstream of the powerhouse. It is likely that these species still inhabit the project area. It is also likely that zebra mussels are now present within the area and that they will affect the populations of other mussels. Evaluation of different dam and gate configurations will not be influenced by the presence of zebra mussels since the mussels will have the same effect on all the configurations considered in Section 6 of this report.

TABLE 5.1

FISH SPECIES OF COMMON OCCURRENCE IN THE ROCK RIVER

Common Name	Scientific Name
American Eel	Anguilla rostrata
Bigmouth Buffalo	Ictiobus cyprinellus
Bigmouth Shiner	Notropis dorsalis
Black Bullhead	Ictalurus melas
Black Crappie	Pomoxis nigromaculatus
Bluegill	Lepomis macrochirus
Bluntnose Minnow	Pimephales notatus
Bowfin	Amia calva
Carp	Cyprinus carpio
Channel Catfish	Ictalurus punctatus
Common Shiner	Notropis cornutus
Creek Chub	Semotilus atromaculatus
Emerald Shiner	Notropis atherinoides
Flathead Catfish	Pylodictis olivaris
Flathead Minnow	Pimephales promelas
Freshwater Drum	Aplodinotus grunniens
Gizzard Shad	Dorosoma cepedianum
Golden Redhorse	Moxostoma erythrurum
Golden Shiner	Notemigonus crysoleucas
Goldeye	Hiodon alosoides
Gravel Chub	Hybopsis x-punctata
Green Sunfish	Lepomis cyanellus
Highfin Carpsucker	Carpiodes velifer
Hornyhead Chub	Nocomis biguttatus
Johny Darter	Etheostoma nigrum
Largemouth Bass	Micropterus salmoides

TABLE 5.1

Common Name	Scientific Name
Logperch	Percina caprodes
Longnose Gar	Lepisosteus osseus
Mooneye	Hiodon tergisus
Northern Hog Sucker	Hypentelium nigricans
Northern River Carpsucker	Carpiodes carpio carpio
Northern Pike	Esox lucius
Orangespotted Sunfish	Lepomis humilis
Paddlefish	Polyodon spathula
Pumpkinseed	Lepomis gibbosus
Quillback	Carpiodes cyprinus
Red Shiner	Notropis lutrensis
Redfin Shiner	Notropis umbratilis
River Shiner	Notropis blennius
Sand Shiner	Notropis stramineus
Sauger	Stizostedion canadense
Shorthead Redhorse	Moxostoma macrolepidotum
Shortnose Gar	Lepisosteus platostomus
Silver Chub	Hybopsis storeriana
Silver Redhorse	Moxostoma anisurum
Smallmouth Bass	Micropterus dolomieui
Smallmouth Buffalo	Ictiobus bubalus
Spotfin Shiner	Notropis spilopterus
Spottail Shiner	Notropis hudsonius
Stonecat	Noturus flavus
Stoneroller	Campostoma anomalom
Suckermouth Minnow	Phenacobius mirabilis
Tadpole Madtom	Noturus gyrinus

TABLE 5.1

Common Name	Scientific Name
White Sucker	Catostomus commersoni
White Crappie	Pomoxis annularis
White Bass	Morone chrysops
Yellow Bullhead	Ictalurus natalis
Yellow Walleye	Stizostedion vitreum vitreum
Yellow Perch	Perca flavescens

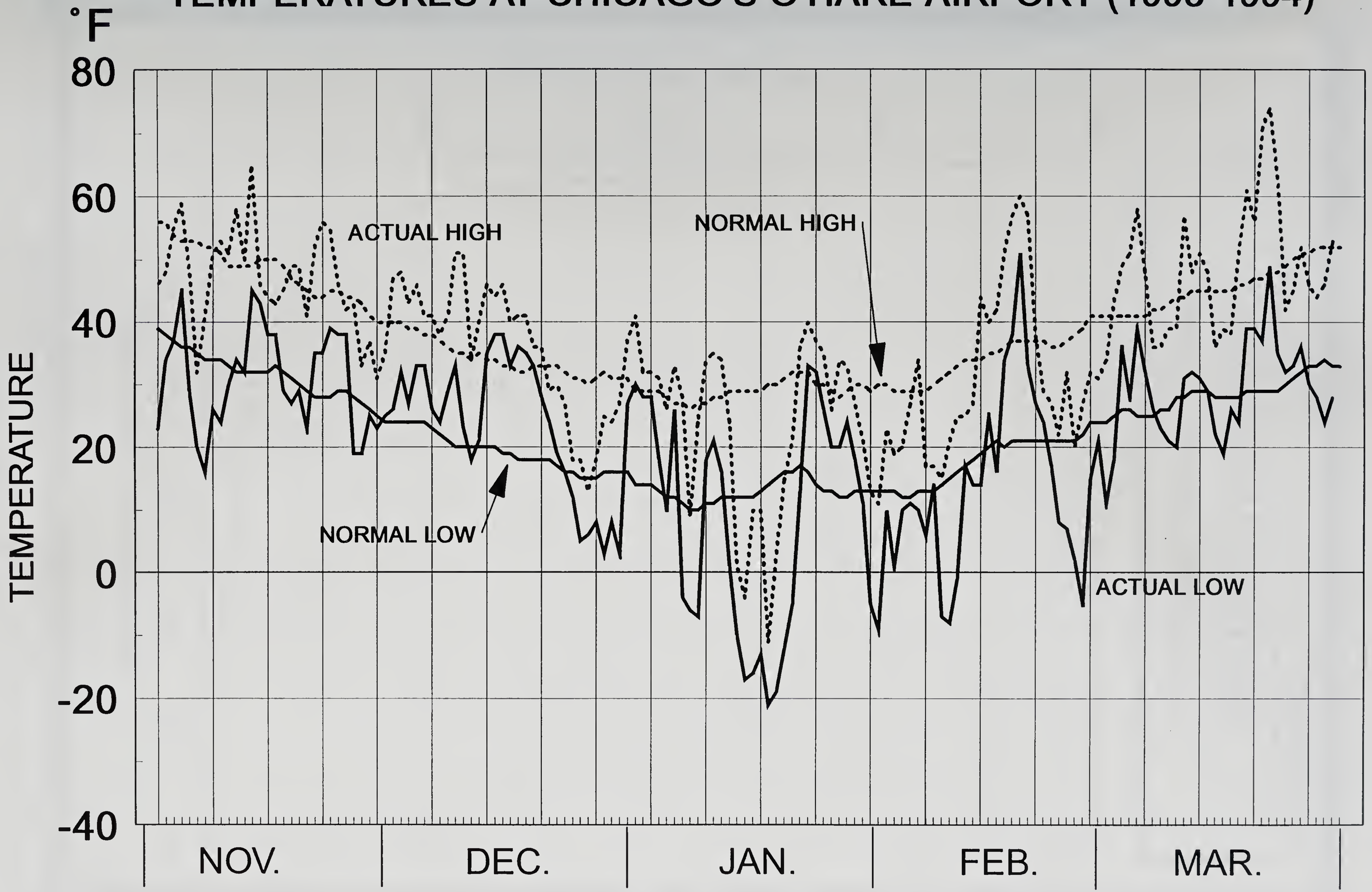
Sources: State of Illinois, Department of Conservation; Smith, 1965; Smith, 1971; and Smith, 1979.

TABLE 5.2

FISH SPECIES OF RARE OCCURRENCE IN THE ROCK RIVER

Common Name	Scientific Name
Blacknose Shiner	Notropis heterolepus
Blackside Darter	Percina maculata
Blackstripe Topminnow	Fundulus notatus
Brook Silverside	Labidesthes sicculus
Brown Trout	Salmo trutta
Central Mudminnow	Umbra limi
Goldfish	Carassius auratus
Lake Sturgeon	Acipenser fulvescens
Norther Bullhead Minnow	Pimephales vigilax perspicuus
Rainbow Trout	Salmo gairdneri
Rock Bass	Ambloplites rupestris
Rosyface Shiner	Notropis rubellus
Shovelnose Sturgeon	Scaphirynchus platorynchus
Skipjack Herring	Alosa chrysochloris
Slenderhead Darter	Percina phoxocephala
Yellow Bass	Morone mississippiensis

Sources: State of Illinois, Department of Conservation;
Smith, 1965; Smith, 1971; and Smith, 1979.



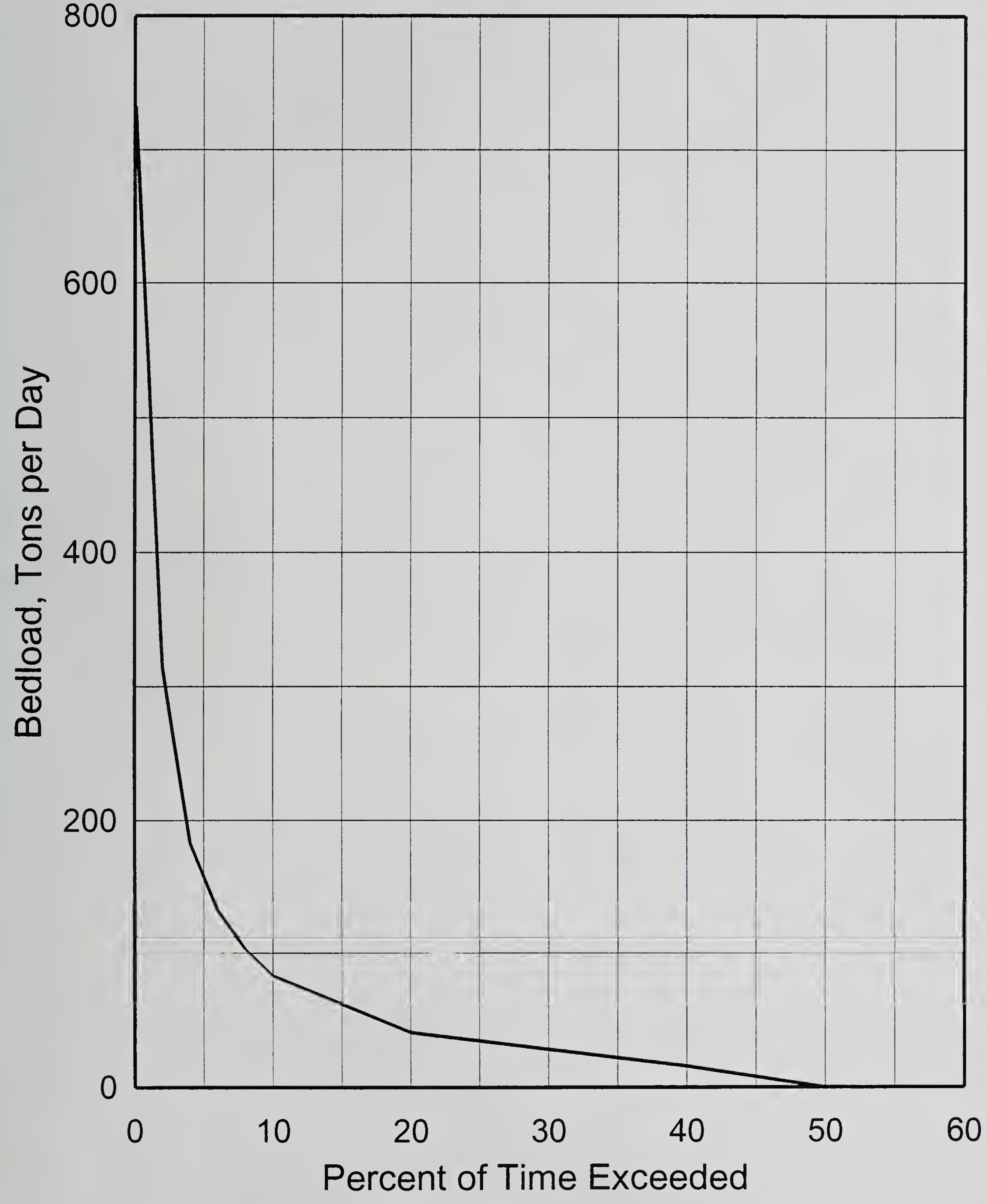
TEMPERATURES AT CHICAGO'S O'HARE AIRPORT (1993-1994)

FIGURE 5.1

FIGURE 5.2

SINNISSIPPI DAM

Bedload Discharge-Rating Curve



6.0 REHABILITATION/RECONSTRUCTION ALTERNATIVES

The original Scope of Services for this feasibility report required the development of alternatives that would replace only the existing radial gates. However, when the preliminary radial gates replacement alternatives (along with their life-cycle cost estimates) were presented to the OWR in a meeting held in Springfield in August of 1994, it was decided that the Scope of this report should be expanded so that the replacement of the fixed-crest overflow section was also included. The preliminary gate replacement alternatives developed are described in Section 6.1. The two gate replacement alternatives selected for further development after the preliminary evaluation, along with alternatives for the replacement of the existing crib dam section, are described in Section 6.2.

6.1 Preliminary Alternatives for Replacement of the Gated Section

Six different preliminary gated section replacement alternatives were developed. Layout drawings, construction schedules, cost estimates and life-cycle cost analyses were developed for each of the alternatives. (The cost estimates were based on preliminary unit prices obtained in 1994 which are slightly different from the more accurate unit prices used for the final alternatives of Section 6.2.) The criteria used for the development and evaluation of the preliminary alternatives is described below:

a. Do not reduce the discharge capacity from that of the existing gates under any Rock River stage/discharge conditions. The discharge capacity of the new gates should be such that the upstream pool water surface elevations either remain the same or are lower than the existing water surface elevations for the same river discharges.

b. Do not change the existing sediment transport regime. Gate sill elevations should be chosen such that the existing sediment transport capacity is maintained.

c. Gate lengths should be chosen such that optimal reservoir water surface elevation control can be accomplished. In addition, the construction and installation will be done in two phases so that significant flood discharge capacity is available during each phase.

d. Alternatives should be evaluated on the basis of capital cost, present value of operation and maintenance costs over the next 60 years and the ability of the gates to satisfactorily operate under winter ice conditions.

A description of the preliminary alternatives developed for the replacement of the gated section follows:

6.1.1 Preliminary Alternative 1: Hydraulic Cylinder Operated Hinged-Leaf Gates

This alternative involves the installation of three 96-foot long and two 45-foot long hydraulic cylinder operated hinged-leaf gates along with a 72 feet long concrete ogee spillway. The total gate length provided is 378 feet, which is the same as the total existing gate length. The existing gates would be used as the upstream cofferdam for the new construction. The elevation of the skin plate with the gate in the fully open position is 626.5 feet (see Figure Prelim 5) as opposed to the existing gates' sill elevation of 626.7 feet. This arrangement will provided almost the same total gate opening area as the existing gates and will not result in any significant changes to the sediment transport regime.

Five new 6-foot thick reinforced concrete piers will be constructed and one existing 8-foot thick concrete end-pier will be extended. Since the number of new piers is less than the existing configuration's, a new concrete ogee spillway with a crest elevation of 636.5 feet is being provided to connect the gated spillway section to the extended end-pier of the existing overflow section. Due to the ogee spillway, the discharge capacity of the dam will be

increased after the reservoir level goes above elevation 636.5 feet.

The initial capital cost of this alternative is estimated to be $4,534,734 and the present value of capital cost and long-term operation and maintenance expenditure is estimated to be $4,690,478. This alternative satisfies the alternative selection criteria regarding discharge capacity, sediment transport, upstream pool water suface elevation control, and satisfactory and reliable operation of the gates during winter ice conditions.

6.1.2 Preliminary Alternative 2: Pneumatically Operated Hinged-Leaf Gates

This alternative involves the installation of three 96-foot long and two 48-foot long pneumatically operated hinged-leaf gates along with a 66-foot long concrete ogee spillway downstream of the existing gates. The total gate length provided is 384 feet, which is 6 feet greater than the existing gate length of 378 feet. The existing gates would be used as the upstream cofferdam for the new construction. The concrete sill elevation is 626.5 feet which is 0.2 feet lower than the existing gates' sill elevation. This arrangement would provide a slightly larger total gate opening area than the existing gates and would not result in any significant changes to the sediment transport regime.

Five new 6-foot thick reinforced concrete piers would be constructed and one existing 8-foot thick concrete end pier would be extended. Since the number of new piers is less than the existing configuration's, a new concrete ogee spillway with a crest elevation of 636.5 feet would be provided to connect the gated spillway section to the extended end-pier of the existing overflow section. Due to the ogee spillway and the increased gate opening area, the discharge capacity of this alternative is higher than the existing dam's discharge capacity under all river flow conditions.

The initial capital cost of this alternative is estimated to be $3,266,391 and the present value of capital cost and long-term operation and maintenance

expenditure is estimated to be $3,547,070. This alternative satisfies the alternative selection criteria regarding discharge capacity, sediment transport, upstream pool water surface elevation control, and satisfactory and reliable operation of the gates during winter ice conditions.

6.1.3 Preliminary Alternative 3: Rubber Dam

This alternative involves the installation of two separate 144-foot long sections of rubber dam and two separate 45-foot long sections of rubber dam downstream of the existing gates. The total rubber dam length at sill elevation is 378 feet which is the same as the existing gates' length. However, the total rubber dam length at the crest (top) is 458 feet. The sill of the rubber dam is at elevation 626.5 feet, compared to the 626.7 feet of the existing gates. This arrangement would provide a greater area open to flow than the existing gates and would not result in any significant changes to the sediment transport regime.

Three new reinforced concrete piers would be constructed and one existing concrete end pier would be extended. The piers would be 6 feet thick at the top and 26 feet thick at the bottom. This alternative would increase the discharge capacity of the dam over the existing dam's capacity due to the increased area available to flow at the gated section.

The initial capital cost of this alternative is estimated to be $3,820,875 and the present value of capital cost and long-term operation and maintenance expenditure is estimated to be $4,080,158. This alternative satisfies the alternative selection criteria regarding discharge capacity, sediment transport, and satisfactory and reliable operation of the gates during winter ice conditions. However, accurate control of the upstream pool water suface elevation would not be possible because of the formation of a "V-notch" in the crest of the rubber dam at certain levels of deflation.

6.1.4 Preliminary Alternative 4: Hybrid of Radial Gates and Rubber Dam

This alternatives involves the installation of four 45-foot long steel radial gates, a 198-foot long section of rubber dam and a 40-foot long concrete ogee spillway at the location of the existing gates. The total gate length, measured along the sills, is 378 feet, which is the same as that of the existing gates. This arrangement would provide a greater area open to flow than the existing gates and would not result in any changes to the sediment transport regime.

This alternative utilizes the alignment of the existing gate section and, therefore, requires an earthern upstream cofferdam. Four 9-foot thick reinforced concrete piers would be constructed for the new radial gates by encasing the existing concrete piers. An additional pier would be built between the rubber dam and the new ogee section. The new construction would require the demolition of thirteen of the existing concrete piers for the installation of the rubber dam. This alternative would have greater discharge capacity than the existing dam's.

The initial capital cost of this alternative is estimated to be $4,138,500 and the present value of capital cost and long-term operation and maintenance expenditure is estimated to be $4,467,906. This alternative satisfies the alternative selection criteria regarding discharge capacity, sediment transport, and satisfactory and reliable operation of the gates during winter ice conditions. The radial gates are only suitable for ice conditions if constantly heated and insulated, because of which the rubber dam section would be used for passing most river discharges and ice during winters. This may cause less accurate control of the upper pool water surface elevation during winters due to the formation of a "V-notch" in the rubber dam crest under certain deflation conditions.

6.1.5 Preliminary Alternative 5: Steel Radial Gates

This alternative involves the installation of nine 42 feet long steel radial gates at the location of the existing gates. As a result, an earthern upstream cofferdam would be required. The total gate length is 378 feet, which is the same as that of the existing gates. Eight new 12 feet thick reinforced concrete piers will be constructed by encasing eight of the existing concrete piers. The remaining nine existing piers will be demolished. This arrangement would not result in any changes to the existing sediment transport regime. There will not be any significant change in the discharge capacity of the dam.

The initial capital cost of this alternative is estimated to be $4,755,088 and the present value of capital cost and long-term operation and maintenance expenditure is estimated to be $5,100,698. This alternative satisfies the alternative selection criteria regarding discharge capacity, sediment transport, and accurate upstream pool elevation control. The radial gates, however, are not suitable for operation during winter ice conditions without large additional costs for insulation and heating. The gates in Alternatives 1, 2 and 3 perform much better and operate more reliably under ice conditions.

6.1.6 Preliminary Alternative 6: Hybrid of Hydraulic Cylinder Operated Hinged-Leaf Gates and One Steel Radial Gate

This alternative involves the installation of two 45-foot long and three 81-foot long hydraulic cylinder operated hinged-leaf gates, one 45-foot long steel radial gate, and a 54-foot long concrete ogee spillway downstream of the existing gates. The total gate length being provided is 378 feet, which is the same as the existing total gate length. The sill elevation is 626.5 feet which is 0.2 feet lower than the existing gates' sill elevation. This arrangement would provide slightly greater total gate opening area as the existing gates' and would not result in any significant changes to the sediment transport

regime.

Five new 6-foot thick reinforced concrete piers would be constructed. One existing concrete end-pier would be extended and two additional 9-foot thick reinforced concrete piers will be constructed that would abut the steel radial gate. Since the number and, hence, total thickness of the new piers is less than the existing configuration's, a new concrete ogee spillway with a crest elevation of 636.5 feet is being provided to connect the end of the new gated section to the end of the existing overflow section. Due to the ogee spillway, the discharge capacity of the dam will be increased after the reservoir level goes above elevation 636.5 feet.

The initial capital cost of this alterative is estimated to be $4,461,572 and the present value of capital cost and long-term operation and maintenance expenditure is estimated to be $4,821,010. This alternative satisfies the alternative selection criteria regarding discharge capacity, sediment transport, upstream pool elevation control, and satisfactory and reliable operation of the gates during winter ice conditions.

6.2 Final Alternatives For Replacing The Entire Dam

In the a meeting with OWR officials in August of 1994, it was decided that the scope of this study be expanded to include development of alternatives for the replacement of the existing crib dam. It was agreed upon that any crib dam replacement alternative should not include provisions for flashboards. As their installation and maintenance are labor intensive and can be dangerous to operating personnel, instead, the discharge capacity provided by flashboards on the existing crib dam should be provided by an additional length of the gated section. It was also decided that only two types of gates, studied as preliminary alternatives and presented in Section 6.1, should be pursued further: 1) pneumatically operated hinged-leaf gates, and 2) hydraulic cylinder operated hinged-leaf gates. These types of gates were chosen because of their better suitability to the overall objectives of the project, most

important of which was reliable and satisfactory operation during winter ice conditions, and because of their lower initial capital cost and lower present value of long-term operation and maintenance expenditure.

The development of alternatives for the replacement of the entire Sinnissippi Dam (gated section and crib dam) followed a sequence and satisfied the criteria described below:

a. A determination was made of whether the new fixed crest overflow section should be constructed at the location of the existing crib dam or whether it should be placed downstream of the crib dam. Constructing it at the location of the existing crib dam would require building a temporary upstream cofferdam and demolition and removal of the existing crib dam. It was determined that building the new fixed-crest section at the location of the existing crib dam would cost an additional $375,000 over building it downstream of the existing crib dam. Therefore, the new fixed-crest spillway was located downstream of the existing crib dam in all the alternatives.

b. Two different types of fixed-crest spillways were considered: 1) conventional mass concrete ogee spillway, and 2) roller compacted concrete spillway.

c. The spillway crest elevation for all the alternatives was fixed at 636.0 feet. The discharge capacity lost due to the elimination of flashboards was provided by increasing the length of the gated section. The total discharge capacity of the site was either kept the same or slightly increased over the existing facilities for all the alternatives.

d. Sediment transport capacity of the gated spillway was maintained.

e. At least one section of a shorter gate/bay length was provided in each alternative so that is could be completely lowered when required for discharging sediment without discharging more water than required.

f. Gate lengths were dictated by the following considerations:

   1. Pneumatically operated hinged-leaf gates come in lengths that are multiples of 16 feet.

   2. For hydraulic cylinder operated hinged-leaf gates, maximum allowable gate lengths as recommended by the manufacturer were taken into account.

   3. Manageable and allowable maintenance bulkhead stoplog lengths. The longer gate/bay lengths were taken to be twice as along as the shorter gate/bay lengths in order to economize on bulkhead initial cost and to streamline their installation and removal/storage effort.

   4. A two-phased construction period was design for the gated section. The gate lengths were determined so as to provide significant flood discharge capacity during each phase of construction.

g. Accurate and fully automated control of the gates was incorporated to maintain a constant upper pool water surface elevation and to keep the upper pool elevation at or below the current levels for all Rock River discharge conditions.

h. Alternatives were evaluated on the basis of capital cost, present value of operation and maintenance costs over the next 60 years, general operation, constructability, and the ability to operate satisfactorily and reliably under winter ice conditions.

A description and evaluation of the final alternatives developed for the replacement of Sinnissippi Dam's gated and crib dam sections follows:

6.2.1 Final Alternative 1: Pneumatically Operated Hinged-leaf Gates with Convetional Concrete Spillway Replacing the Existing Gates, Flashboards, Crib Dam and Right Bank Powerhouse Ruins

This alternative involves the installation and construction of two 32-foot long and seven 64-foot long pneumatically operated hinged-leaf gates, and a 672-foot long conventional concrete ogee spillway. The new structures will be constructed downstream of the existing crib dam. Please see Figure Final 1" in Section 12 for a plan of this alternative. Construction of the new structures would require demolition and removal of the existing gates and piers, a 72-foot long section of the existing crib dam, and the entire right bank abandoned powerhouse's substructure.

The new structures would be constructed in three phases. Phase-I (see Figure Final 2") would consist of the installation of one 32-foot long and three 64-foot long pneumatically operated hinged-leaf gates. The existing gates would be used as the upstream cofferdam. In addition, a temporary earthfill cofferdam would be constructed downstream of the gates to allow for construction in the dry. After the construction of the new gates is complete, ten of the existing steel radial gates would be removed and nine of the existing concrete piers would be demolished and removed in the wet. During this construction, six of the existing steel radial gates would remain operational. The discharge capacity of the site during Phase-I construction with the upstream pool at elevation 636.5 feet and no flashboards on the crib dam would be approximately 21,000 cfs (based on Ref. 4), which corresponds to the 1% or less flow exceedence interval during the anticipated construction months of May through January.

Phase-II construction would consist of the installation of one 32-foot long and four 64-foot long pneumatically operated hinged-leaf gates (please see Figure Final 3"). The remaining eight steel radial gates and part of the existing crib dam with flashboards would be used as the upstream cofferdam. A temporary

earthfill cofferdam would also be built on the downstream side of the construction. After the construction and installation of the new gates is complete, the remaining eight existing steel radial gates would be removed in the wet. In addition, all eight of the remaining existing concrete piers, the existing concrete dam abutment/pier, and a 72 feet section of the existing crib dam would be demolished and removed. The new gates constructed during Phase-I would remain operational during Phase-II construction. The site's discharge capacity during Phase-II construction would be approximately 25,000 cfs.

Phase-III would consist of the construction of a 672-foot long conventional mass concrete spillway will be constructed (please see Figure Final 4" for a plan). The spillway will be constructed immediately downstream of the existing crib dam, which will also act as a form for part of the upstream face of the new concrete spillway (please see the cross-section on Figure Final 17"). The construction of the spillway will require the demolition and removal of the abandoned ruins of the right bank powerhouse's substructure. The existing crib dam with flashboards would be used as the upstream cofferdam. However, a temporary earthfill cofferdam would be required around the upstream faces of the existing abandoned powerhouse substructure to allow for its demolition/removal and the subsequent spillway construction in the dry. In addition, a temporary earthfill cofferdam would be built downstream of the spillway. During Phase-III construction, all the new gates installed during the two earlier phases would remain operational which would provide a discharge capacity of 38,000 cfs. Upon completion of construction of the new spillway, the flashboards from the existing crib dam would be removed, however, the crib dam itself would be left in place.

This alternative would increase the total discharge capacity of Sinnissippi Dam over that of the existing structures under all headwater conditions. The gate operation would be fully automated and would not require the presence of an on-site operator. Both local and remote manual control of the gates would be

provided for.

The initial capital cost of this alternative is estimated to be $6,664,867 and the present value of capital cost and long-term operation and maintenance expenditure is estimated to be $7,025,026. This alternative satisfies all the technical and O&M related alternative selection criteria that includes providing adequate hydraulic discharge capacity, not changing the existing sediment transport regime, accurate and unmanned upstream pool water surface elevation control, satisfactory and reliable operation of the gates during winter ice conditions, and simple and infrequent long-term maintenance.

6.2.2 Final Alternative 2: Pneumatically Operated Hinged-leaf Gates with Convetional Concrete Spillway Replacing the Existing Gates, Flashboards and Crib Dam, and Jet Grouting of the Right Bank Powerhouse Ruins.

This alternative involves the installation and construction of three 48-foot long and four 96-foot long pneumatically operated hinged-leaf gates, and a 504-foot long conventional concrete ogee spillway. The new structures would be constructed downstream of the existing crib dam. Please see Figure Final 5" in Section 12 for a plan of this alternative. Construction of the new structures would require demolition and removal of the existing gates and piers, and a 76-foot long section of the existing crib dam. The right bank abandoned powerhouse's substructure would remain intact, however, a jet-grouted cut-off wall would be provided for a positive seepage cut-off.

The new structures would be constructed in three phases. Phase-I (see Figure Final 6") would consist of the installation of one 48-foot long and two 96-foot long pneumatically operated hinged-leaf gates. The existing gates would be used as the upstream cofferdam. In addition, a temporary earthfill cofferdam would be constructed downstream of the gates to allow for construction in the dry. After the construction of the new gates is complete, ten of the existing steel radial gates would be removed and nine of the existing concrete piers

would be demolished and removed in the wet. During this construction, six of the existing steel radial gates would remain operational. The discharge capacity of the site during Phase-I construction with the upstream pool water surface at elevation 636.5 feet and no flashboards on the crib dam would be approximately 21,000 cfs (based on Ref. 4), which corresponds to the 1% or less flow exceedence interval during the anticipated construction months of May through December.

Phase-II construction would consist of the installation of two 48-foot long and two 96-foot long pneumatically operated hinged-leaf gates (please see Figure Final 3"). The remaining eight steel radial gates and part of the existing crib dam with flashboards would be used as the upstream cofferdam. A temporary earthfill cofferdam would also be built on the downstream side. After the construction and installation of the new gates is complete, the remaining eight existing steel radial gates as well as all eight of the remaining existing concrete piers, the existing concrete dam abutment/pier, and a 76-foot section of the existing crib dam would be demolished and removed. The new gates constructed during Phase-I would remain operational during Phase-II construction. The site's discharge capacity during Phase-II construction would be approximately 26,000 cfs.

Phase-III would consist of the construction of a 504-foot long conventional mass concrete spillway and a jet-grouted cut-off wall in the abandoned right bank powerhouse substructure (please see Figure Final 8" for a plan). The spillway would be constructed immediately downstream of the existing crib dam, which would also act as the upstream cofferdam and as a form for part of the upstream face of the new concrete spillway (please see the cross-section on Figure Final 17"). A temporary earthfill cofferdam will be built downstream of the spillway to allow for construction in the dry. The left abutment of the new ogee spillway would consist of an 8-foot thick reinforced concrete pier, whereas, the existing powerhouse substructure would form its right abutment. The interface between the new spillway and the powerhouse

substructure would be grouted. During Phase-III construction, all the new gates installed during the two earlier phases would remain operational which would provide a discharge capacity of 39,000 cfs. After construction of the new spillway is complete, the flashboards from the existing crib dam would be removed, however, the crib dam itself would remain in place.

This alternative would increase the total discharge capacity at Sinnissippi Dam over that of the existing structures under all headwater conditions. The gate operation will be fully automated and would not require the presence of an on-site operator. Both local and remote manual control of the gates would be provided for.

The initial capital cost of this alternative is estimated to be $6,136,625 and the present value of capital cost and long-term operation and maintenance expenditure is estimated to be $6,601,893. This alternative satisfies all the technical and O&M related alternative selection criteria that includes providing adequate hydraulic discharge capacity, not changing the existing sediment transport regime, accurate and unmanned upstream pool water surface elevation control, satisfactory and reliable operation of the gates during winter ice conditions, and simple and infrequent long-term maintenance.

6.2.3 Final Alternative 3: Pneumatically Operated Hinged-leaf Gates with Roller Compacted Concrete Spillway Replacing the Existing Gates, Flashboards, Crib Dam and Right Bank Powerhouse Ruins

This alternative involves the installation and construction of two 32-foot long and seven 64-foot long pneumatically operated hinged-leaf gates, and a 672-foot long roller compacted concrete spillway. The new structures would be constructed downstream of the existing crib dam. Please see Figure Final 1" in Section 12 for a plan of this alternative. Construction of the new structures would require demolition and removal of the existing gates and piers, a 72-

foot long section of the existing crib dam, and the entire right bank abandoned powerhouse's substructure.

The new structures would be constructed in three phases. Phase-I (see Figure Final 2") would consist of the installation of one 32-foot long and three 64-foot long pneumatically operated hinged-leaf gates. The existing gates would be used as the upstream cofferdam and a temporary earthfill cofferdam would be constructed downstream of the gates to allow for construction in the dry. After the construction of the new gates is complete, ten of the existing steel radial gates and nine of the existing concrete piers would be demolished and removed. During this construction, six of the existing steel radial gates would remain operational. The discharge capacity of the site during Phase-I construction with the upstream pool water surface at elevation 636.5 feet and no flashboards on the crib dam would be approximately 21,000 cfs (based on Ref. 4), which corresponds to the 1% or less flow exceedence interval during the anticipated construction months of May through December.

Phase-II would consist of the installation of one 32-foot long and four 64-foot long pneumatically operated hinged-leaf gates (please see Figure Final 3"). The remaining eight steel radial gates and part of the existing crib dam with flashboards would be used as the upstream cofferdam and a temporary earthfill cofferdam would be constructed downstream. After the construction and installation of the new gates is complete, the remaining eight existing steel radial gates, all eight of the remaining existing concrete piers, the existing concrete dam abutment/pier, and a 72-foot section of the existing crib dam would be demolished and removed. The new gates constructed during Phase-I would remain operational during Phase-II construction and have a discharge capacity of approximately 25,000 cfs.

Phase-III would consist of the construction of a 672-foot long roller compacted concrete spillway (please see Figure Final 4" for a plan). The spillway would be constructed on an alignment immediately downstream of the existing crib

dam and through the existing powerhouse ruins. The existing crib dam would act as a part of the upstream cofferdam and as a form for part of the upstream face of the new roller compaced concrete spillway. A typical cross-section of the roller compacted concrete spillway is shown on Figure Final 18". At the location of the existing powerhouse ruins, the construction of the spillway would require the demolition and removal of the abandoned ruins which in turn requires an earthern upstream cofferdam. In addition, a temporary earthfill cofferdam would be required downstream of the entire spillway. During Phase-III construction, all the new gates installed during the two earlier phases would remain operational providing discharge capacity of approximately 38,000 cfs. After construction of the new spillway is complete, the flashboards from the existing crib dam would be removed with the crib dam itself remaining in place.

This alternative would increase the total discharge capacity at Sinnissippi Dam over that of the existing structures under all headwater conditions. The gate operation will be fully automated and would not require the presence of an on-site operator. Both local and remote manual control of the gates would be provided for.

The initial capital cost of this alternative is estimated to be $6,224,242 and the present value of capital cost and long-term operation and maintenance expenditure is estimated to be $6,764,401. This alternative satisfies all the technical and O&M related alternative selection criteria that includes providing adequate hydraulic discharge capacity, not changing the existing sediment transport regime, accurate and unmanned upstream pool water surface elevation control, satisfactory and reliable operation of the gates during winter ice conditions, and simple and infrequent long-term maintenance.

6.2.4 Final Alternative 4: Hydraulic Cylinder Operated Hinged-leaf Gates with Convetional Concrete Spillway Replacing the Existing Gates, Flashboards, Crib Dam and Right Bank Powerhouse Ruins

This alternative involves the installation and construction of two 42-foot long and five 84-foot long hydraulic cylinder operated hinged-leaf gates, and a 692-foot long conventional concrete ogee spillway. The new structures would be constructed downstream of the existing crib dam. Please see Figure Final 9" in Section 12 for a plan of this alternative. Construction of the new structures would require demolition and removal of the existing gates and piers, a 52-foot long section of the existing crib dam, and the entire right bank abandoned powerhouse's substructure.

The new structures would be constructed in three phases. Phase-I (see Figure Final 10") would consist of the installation of one 42-foot long and two 84-foot long hydraulic cylinder operated hinged-leaf gates. The existing gates would be used as the upstream cofferdam and a temporary earthfill cofferdam would be constructed downstream of the gates to allow for construction in the dry. After the construction of the new gates is complete, nine of the existing steel radial gates and eight of the existing concrete piers would be demolished and removed. During this construction, seven of the existing steel radial gates would remain operational. The discharge capacity of the site during Phase-I construction with the upstream pool at elevation 636.5 feet and no flashboards on the crib dam would be 23,000 cfs (based on Ref. 4), which corresponds to the less than 1% flow exceedence interval during the anticipated construction months of May through December.

Phase-II construction consists of the installation of one 42-foot long and three 84-foot long hydraulic cylinder operated hinged-leaf gates (please see Figure Final 11"). The remaining eight steel radial gates and part of the existing crib dam with flashboards would be used as the upstream cofferdam and a temporary earthfill cofferdam would be constructed on the downstream side.

After the construction and installation of the new gates is complete, the remaining nine existing steel radial gates, all nine of the remaining existing concrete piers, the existing concrete dam abutment/pier, and a 52-foot section of the existing crib dam would be demolished and removed. The new gates constructed during Phase-I would remain operational during Phase-II construction, resulting in a discharge capacity of approximately 24,000 cfs at a headwater elevation of 636.5 feet.

Phase-III would consist of the construction of a 692-foot long conventional mass concrete ogee spillway (please see Figure Final 12" for a plan), constructed immediately downstream of the existing crib dam, which would act as part of the upstream cofferdam and as a form for part of the upstream face of the new concrete spillway (please see the cross-section on Figure Final 17"). The construction of the spillway would require the demolition and removal of the abandoned ruins of the right bank powerhouse's substructure and require a temporary earthfill cofferdam upstream of the ruins to allow construction in the dry. In addition, a temporary earthfill cofferdam would also be constructed downstream of the spillway. During Phase-III construction, all the new gates installed during the two earlier phases would remain operational which would provide a discharge capacity of approximately 37,600 cfs. After construction of the new spillway is complete, the flashboards from the existing crib dam would be removed, with the crib dam itself remaining in place.

This alternative will increase the total discharge capacity at Sinnissippi Dam over that of the existing structures under all headwater conditions. The gate operation would be fully automated and would not require the presence of an on-site operator. Both local and remote manual control of the gates would be provided for.

The initial capital cost of this alternative is estimated to be $8,150,406 and the present value of capital cost and long-term operation and maintenance

expenditure is estimated to be $8,544,243. This alternative satisfies all the technical and O&M related alternative selection criteria that includes providing adequate hydraulic discharge capacity, not changing the existing sediment transport regime, accurate and unmanned upstream pool water surface elevation control, satisfactory and reliable operation of the gates during winter ice conditions, and simple and infrequent long-term maintenance.

6.2.5 Final Alternative 5: Hydraulic Cylinder Operated Hinged-leaf Gates with Convetional Concrete Spillway Replacing the Existing Gates, Flashboards and Crib Dam, and Jet Grouting of the Right Bank Powerhouse Ruins.

This alternative involves the installation and construction of two 43-foot long and five 86-foot long hydraulic cylinder operated hinged-leaf gates, and a 516-foot long conventional concrete ogee spillway. The new structures would be constructed downstream of the existing crib dam. Please see Figure Final 13" in Section 12 for a plan of this alternative. Construction of the new structures would require demolition and removal of the existing gates and piers, and a 64 feet long section of the existing crib dam. The right bank abandoned powerhouse's substructure would remain intact, however, a jet-grouted cut-off wall would be constructed to provide positive seepage cut-off.

The new structures would be constructed in three phases. Phase-I (see Figure Final 14") would consist of the installation of one 43-foot long and two 86-foot long hydraulic cylinder operated hinged-leaf gates. The existing gates would be used as the upstream cofferdam and a temporary earthfill cofferdam would be constructed downstream of the gates to allow for construction in the dry. After the construction of the new gates is complete, nine of the existing steel radial gates and eight of the existing concrete piers would be demolished and removed. During this construction, seven of the existing steel radial gates would remain operational. The discharge capacity of the site during Phase-I construction with the upstream pool at elevation 636.5 feet and no flashboards on the crib dam would be approximately 23,000 cfs (based on Ref. 4), which

corresponds to the less than 1% flow exceedence interval during the anticipated construction months of May through December.

Phase-II construction consists of the installation of one 43-foot long and three 86-foot long hydraulic cylinder operated hinged-leaf gates (please see Figure Final 15"). The remaining nine steel radial gates and part of the existing crib dam with flashboards would be used as the upstream cofferdam and a temporary earthfill cofferdam would be constructed on the downstream side. After the construction and installation of the new gates is complete, the remaining nine existing steel radial gates, all nine of the remaining existing concrete piers, the existing concrete dam abutment/pier, and a 64 feet section of the existing crib dam would be demolished and removed. The new gates constructed during Phase-I would remain operational during Phase-II construction resulting in a discharge capacity of approximately 24,600 cfs for a headwater elevation of 636.5 feet.

Phase-III would consist of the construction of a 516-foot long conventional mass concrete ogee spillway and a jet-grouted cut-off wall through the abandoned right bank powerhouse substructure (please see Figure Final 16" for a plan). The spillway would be constructed immediately downstream of the existing crib dam, which would act as the upstream cofferdam and as a form for part of the upstream face of the new concrete spillway (please see the cross-section on Figure Final 17"). The left abutment of the new spillway would consist of an 8-foot thick reinforced concrete pier, whereas, the existing powerhouse substructure would form its right abutment. The interface between the new spillway and the powerhouse substructure would be grouted. A temporary earthfill cofferdam would be constructed downstream of the spillway to allow for construction in the dry. During Phase-III construction, all the new gates installed during the two earlier phases would remain operational which would provide a discharge capacity of approximately 38,500 cfs. After construction of the new spillway is complete, the flashboards from the existing crib dam would be removed with the crib dam itself remaining in

place.

This alternative will increase the total discharge capacity at Sinnissippi Dam over that of the existing structures under all headwater conditions. The gate operation would be fully automated and would not require the presence of an on-site operator. Both local and remote manual control of the gates would be provided for.

The initial capital cost of this alternative is estimated to be $7,590,217 and the present value of capital cost and long-term operation and maintenance expenditure is estimated to be $7,984,054. This alternative satisfies all the technical and O&M related alternative selection criteria that includes providing adequate hydraulic discharge capacity, not changing the existing sediment transport regime, accurate and unmanned upstream pool water surface elevation control, satisfactory and reliable operation of the gates during winter ice conditions, and simple and infrequent long-term maintenance.

6.2.6 Final Alternative 6: Hydraulic Cylinder Operated Hinged-leaf Gates with Roller Compacted Concrete Spillway Replacing the Existing Gates, Flashboards, Crib Dam and Right Bank Powerhouse Ruins.

This alternative involves the installation and construction of two 42-foot long and five 84-foot long hydraulic cylinder operated hinged-leaf gates, and a 692-foot long roller compacted concrete spillway with a stepped downstream face. The new structures would be constructed downstream of the existing crib dam. Please see Figure Final 9" in Section 12 for a plan of this alternative. Construction of the new structures would require demolition and removal of the existing gates and piers, a 52 feet long section of the existing crib dam, and the entire right bank abandoned powerhouse's substructure.

The new structures would be constructed in three phases. Phase-I (see Figure Final 10") would consist of the installation of one 42-foot long and two 84-

foot long hydraulic cylinder operated hinged-leaf gates. The existing gates would be used as the upstream cofferdam and a temporary earthfill cofferdam would be constructed downstream of the gates to allow for construction in the dry. After the construction of the new gates is complete, nine of the existing steel radial gates and eight of the existing concrete piers will be demolished and removed. During this construction, seven of the existing steel radial gates would remain operational. The discharge capacity of the site during Phase-I construction with the upstream pool at elevation 636.5 feet and no flashboards on the crib dam would be approximately 23,000 cfs (based on Ref. 4), which corresponds to the less than 1% flow exceedence interval during the anticipated construction months of May through December.

Phase-II construction would consist of the installation of one 42-foot long and three 84-foot long hydraulic cylinder operated hinged-leaf gates (please see Figure Final 11"). The remaining eight steel radial gates and part of the existing crib dam with flashboards would be used as the upstream cofferdam and a temporary earthfill cofferdam would be constructed on the downstream side. After the construction and installation of the new gates is complete, the remaining nine existing steel radial gates, all nine of the remaining existing concrete piers, the existing concrete dam abutment/pier, and a 52 feet section of the existing crib dam would be demolished and removed. The new gates constructed during Phase-I would remain operational during Phase-II construction resulting in a discharge capacity of approximately 24,000 cfs for a headwater elevation of 636.5 feet.

Phase-III would consist of the construction of a 692-foot long roller compacted concrete spillway (please see Figure Final 12" for a plan) immediately downstream of the existing crib dam, which would act as part of the upstream cofferdam and as a form for part of the upstream face of the new concrete spillway (please see the cross-section on Figure Final 18"). The construction of the spillway would require the demolition and removal of the abandoned ruins of the right bank powerhouse's substructure and a temporary earthfill

cofferdam would be constructed around the upstream faces of the existing abandoned powerhouse substructure to allow for its demolition/removal and the subsequent spillway construction in the dry. In addition, a temporary earthfill cofferdam would be constructed downstream of the spillway. During Phase-III construction, all the new gates installed during the two earlier phases would remain operational which would provide a discharge capacity of 37,600 cfs. After construction of the new spillway is complete, the flashboards from the existing crib dam would be removed with the crib dam itself remaining in place.

This alternative would increase the total discharge capacity at Sinnissippi Dam over that of the existing structures under all headwater conditions. The gate operation would be fully automated and would not require the presence of an on-site operator. Both local and remote manual operation of the gates would be provided for.

The initial capital cost of this alternative is estimated to be $7,700,406 and the present value of capital cost and long-term operation and maintenance expenditure is estimated to be $8,094,243. This alternative satisfies all the technical and O&M related alternative selection criteria that includes providing adequate hydraulic discharge capacity, not changing the existing sediment transport regime, accurate and unmanned upstream pool water surface elevation control, satisfactory and reliable operation of the gates during winter ice conditions, and simple and infrequent long-term maintenance.

7.0 LIFE-CYCLE COST ANALYSIS

A life-cycle cost analysis was performed for all the preliminary and final alternatives developed in order to arrive at the most cost-effective solution for the Sinnissippi Dam reconstruction. In order to carry out the analysis, quantities of materials required for the construction of each alternative were first estimated. Cost estimates were then developed for each alternative based on those quantities. The life-cycle cost analysis was then carried out by computing the present value of the initial capital cost and all anticipated operation and maintenance expenditure for sixty years after the project is commissioned.

The following assumptions were made for the essential variables used in the life-cycle cost analysis:

- Project capital costs are based on 1995 dollars.
- The long-term cost of capital is 8.0%.
- The long-term average rate of inflation is 4.0%.
- The initial cost per kilowatt-hour of electricity is $0.10.
- Each abutment heater's capacity is 4 kilowatts.
- The heaters along the length of the gates have energy requirements of 8 Watts per square foot.
- Gate heaters will be used for an average of 90 days every year.

An analysis was also made of the cost savings to the City of Rock Falls associated with the elimination of the provision for flashboards on the proposed crib dam replacement alternatives. This analysis is described in Section 7.1. The life-cycle cost analysis and its results are further discussed in Section 7.2.

7.1 Analysis of the Savings to the City of Rock Falls due to Flashboards Elimination

An analysis was performed of the benefits to the City of Rock Falls due to the elimination of the provision for flashboards on the crest of the proposed crib dam replacement alternatives and their replacement with a fixed crest of equal elevation. The City owns the existing hydroelectric powerplant on the left bank of the river The benefits and cost savings to the City would accrue due to the following reasons:

1. Every year the City spends several thousand dollars in material and labor costs to reinstall flashboards that are washed out during floods or pushed-out by ice. The elimination of flashboards will result in significant savings in yearly maintenance expenditure.

2. A significant amount of energy generation potential is lost every year because the powerhouse has to be shut down due to insufficient head and discharge available for power generation caused by the wash out of flashboards. The elimination of flashboards from the crest of the proposed fixed-crest section will allow the maintenance of a stable upstream pool level which would alleviate such problems.

Mr. Robert O'Donnell of the City of Rock Falls Electrical Department was contacted to get the available data on which the analysis is based. They provided the following information.

1. The City spent approximately $5,000 on the fabrication and installation of flashboards in 1995.

2. Approximately one-third of the energy generation potential is lost for an average of three months every year due to insufficient head and discharge available for power generation caused by flashboard wash out. This corresponds to approximately 975,000 kWh per year which translates into $58,500 per year at the energy rate of $0.06 per kWh.

The above information was used to perform the analysis in which the following procedures and parameters were used:

- The analysis was made assuming that benefits to the City would accrue for a period of 40 years after the Sinnissippi Dam rehabilitation/reconstruction project is completed in 1998. This assumption takes into account the fact that the City's powerplant site lease will expire 40 years after the completion of the project.

- Keeping the discount rate at 8%, the flashboard fabrication, installation and maintenance were escalated at different long-term inflation rates of 3.0%, 3.5%, 4.0%, 4.5% and 5.0%.

- Keeping the long-term inflation rate at 4%, different discount rates of 6%, 7%, 8%, 9% and 10% were used.

- The price of energy was not escalated from the $0.06 per kWh provided by the Rock Falls Electrical Department. This is a conservative assumption which results in the estimation of lower benefits to the City, and assumes that the City might have entered into constant long-term power purchase/sale price agreements.

- Benefit accrual has been discounted back to 1995 dollars.

The results of the analysis are summarized in Table 7.1 (at the end of this section). The present value of total benefits that would accrue to the City vary between $484,260 and $892,498 depending upon which combination of long-term inflation rate and discount rate is used. We recommend using an inflation rate of 3% and a discount rate of 8% which results in benefits of $627,538. This is a somewhat conservative number (resulting in lower benefits to the City) because the City's weighted average cost of capital is probably lower than 8% since it is a municipality. The details of the analysis are presented in Table 7.2.

7.2 Results and Conclusions of the Life-cycle Cost Analysis

The results of the life-cycle cost analysis are summarized in Table 7.3. The total initial capital expenditure varies between $6,136,625 and $8,150,406, and the present value of the capital cost and long-term capital expenditure varies between $6,601,893 and $8,544,243. Table 7.4 shows the detailed cost estimates for all the alternatives and Table 7.5 shows the detailed life-cycle cost analysis.

Alternative 2, pneumatically operated hinged-leaf gates with conventional mass concrete ogee spillway and jet-grouting of the existing right bank powerhouse substructure, is the lowest cost alternative. This alternative also results in the lowest present value of costs when yearly overhead and maintenance expenditure are taken into account. Therefore, this alternative is being recommended as the final configuration for the reconstruction of Sinnissippi Dam. This recommendation and conclusion are further discussed in Section 9 of this report.

It should be noted that all costs are in 1995 dollars. The financial variables, discount rate of 8% and inflation rate of 4%, used in the analysis are conservative. However, they are being used to compare the cost-effectiveness of the different alternatives whose relative costs will not change by changing these variables. Hence, changing the discount rate and the inflation rate will not change the results of this study as far as choosing the most economical alternative is concerned.

TABLE 7.1

FEASIBILITY STUDY FOR THE REHABILITATION OR RECONSTRUCTION OF SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

SUMMARY

Cost/kWh	$0.06
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

PRESENT VALUE (1995)

INFLATION RATE	DISCOUNT RATE				
	6.0%	7.0%	8.0%	9.0%	10.0%
3.0%	$843,528	$723,903	$627,538	$548,995	$484,260
3.5%	$853,631	$731,806	$633,793	$554,005	$488,319
4.0%	$865,029	$740,676	$640,780	$559,572	$492,807
4.5%	$877,911	$750,653	$648,598	$565,772	$497,780
5.0%	$892,498	$761,896	$657,366	$572,691	$503,303

TABLE 7.2

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	6.00%
Cost/kWh	$0.06
Inflation rate	3.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,467	$58,500	$63,967
2	$5,631	$58,500	$64,131
3	$5,800	$58,500	$64,300
4	$5,974	$58,500	$64,474
5	$6,154	$58,500	$64,654
6	$6,338	$58,500	$64,838
7	$6,528	$58,500	$65,028
8	$6,724	$58,500	$65,224
9	$6,926	$58,500	$65,426
10	$7,134	$58,500	$65,634
11	$7,348	$58,500	$65,848
12	$7,568	$58,500	$66,068
13	$7,795	$58,500	$66,295
14	$8,029	$58,500	$66,529
15	$8,270	$58,500	$66,770
16	$8,518	$58,500	$67,018
17	$8,773	$58,500	$67,273
18	$9,037	$58,500	$67,537
19	$9,308	$58,500	$67,808
20	$9,587	$58,500	$68,087
21	$9,875	$58,500	$68,375
22	$10,171	$58,500	$68,671
23	$10,476	$58,500	$68,976
24	$10,790	$58,500	$69,290
25	$11,114	$58,500	$69,614
26	$11,447	$58,500	$69,947
27	$11,791	$58,500	$70,291
28	$12,144	$58,500	$70,644
29	$12,509	$58,500	$71,009
30	$12,884	$58,500	$71,384
31	$13,271	$58,500	$71,771
32	$13,669	$58,500	$72,169
33	$14,079	$58,500	$72,579
34	$14,501	$58,500	$73,001
35	$14,936	$58,500	$73,436
36	$15,384	$58,500	$73,884
37	$15,846	$58,500	$74,346
38	$16,321	$58,500	$74,821
39	$16,811	$58,500	$75,311
40	$17,315	$58,500	$75,815
		NPV =	***$843,528***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	6.00%
Cost/kWh	$0.06
Inflation rate	3.50%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,547	$58,500	$64,047
2	$5,741	$58,500	$64,241
3	$5,942	$58,500	$64,442
4	$6,150	$58,500	$64,650
5	$6,366	$58,500	$64,866
6	$6,588	$58,500	$65,088
7	$6,819	$58,500	$65,319
8	$7,058	$58,500	$65,558
9	$7,305	$58,500	$65,805
10	$7,560	$58,500	$66,060
11	$7,825	$58,500	$66,325
12	$8,099	$58,500	$66,599
13	$8,382	$58,500	$66,882
14	$8,676	$58,500	$67,176
15	$8,979	$58,500	$67,479
16	$9,294	$58,500	$67,794
17	$9,619	$58,500	$68,119
18	$9,956	$58,500	$68,456
19	$10,304	$58,500	$68,804
20	$10,665	$58,500	$69,165
21	$11,038	$58,500	$69,538
22	$11,424	$58,500	$69,924
23	$11,824	$58,500	$70,324
24	$12,238	$58,500	$70,738
25	$12,666	$58,500	$71,166
26	$13,110	$58,500	$71,610
27	$13,569	$58,500	$72,069
28	$14,043	$58,500	$72,543
29	$14,535	$58,500	$73,035
30	$15,044	$58,500	$73,544
31	$15,570	$58,500	$74,070
32	$16,115	$58,500	$74,615
33	$16,679	$58,500	$75,179
34	$17,263	$58,500	$75,763
35	$17,867	$58,500	$76,367
36	$18,492	$58,500	$76,992
37	$19,140	$58,500	$77,640
38	$19,810	$58,500	$78,310
39	$20,503	$58,500	$79,003
40	$21,221	$58,500	$79,721

NPV = $853,631

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	6.00%
Cost/kWh	$0.06
Inflation rate	4.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,628	$58,500	$64,128
2	$5,853	$58,500	$64,353
3	$6,087	$58,500	$64,587
4	$6,331	$58,500	$64,831
5	$6,584	$58,500	$65,084
6	$6,847	$58,500	$65,347
7	$7,121	$58,500	$65,621
8	$7,406	$58,500	$65,906
9	$7,702	$58,500	$66,202
10	$8,011	$58,500	$66,511
11	$8,331	$58,500	$66,831
12	$8,664	$58,500	$67,164
13	$9,011	$58,500	$67,511
14	$9,371	$58,500	$67,871
15	$9,746	$58,500	$68,246
16	$10,136	$58,500	$68,636
17	$10,541	$58,500	$69,041
18	$10,963	$58,500	$69,463
19	$11,401	$58,500	$69,901
20	$11,858	$58,500	$70,358
21	$12,332	$58,500	$70,832
22	$12,825	$58,500	$71,325
23	$13,338	$58,500	$71,838
24	$13,872	$58,500	$72,372
25	$14,427	$58,500	$72,927
26	$15,004	$58,500	$73,504
27	$15,604	$58,500	$74,104
28	$16,228	$58,500	$74,728
29	$16,877	$58,500	$75,377
30	$17,552	$58,500	$76,052
31	$18,254	$58,500	$76,754
32	$18,984	$58,500	$77,484
33	$19,744	$58,500	$78,244
34	$20,533	$58,500	$79,033
35	$21,355	$58,500	$79,855
36	$22,209	$58,500	$80,709
37	$23,097	$58,500	$81,597
38	$24,021	$58,500	$82,521
39	$24,982	$58,500	$83,482
40	$25,981	$58,500	$84,481
		NPV =	***$865,029***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	6.00%
Cost/kWh	$0.06
Inflation rate	4.50%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,710	$58,500	$64,210
2	$5,967	$58,500	$64,467
3	$6,235	$58,500	$64,735
4	$6,516	$58,500	$65,016
5	$6,809	$58,500	$65,309
6	$7,115	$58,500	$65,615
7	$7,435	$58,500	$65,935
8	$7,770	$58,500	$66,270
9	$8,120	$58,500	$66,620
10	$8,485	$58,500	$66,985
11	$8,867	$58,500	$67,367
12	$9,266	$58,500	$67,766
13	$9,683	$58,500	$68,183
14	$10,119	$58,500	$68,619
15	$10,574	$58,500	$69,074
16	$11,050	$58,500	$69,550
17	$11,547	$58,500	$70,047
18	$12,067	$58,500	$70,567
19	$12,610	$58,500	$71,110
20	$13,177	$58,500	$71,677
21	$13,770	$58,500	$72,270
22	$14,390	$58,500	$72,890
23	$15,037	$58,500	$73,537
24	$15,714	$58,500	$74,214
25	$16,421	$58,500	$74,921
26	$17,160	$58,500	$75,660
27	$17,932	$58,500	$76,432
28	$18,739	$58,500	$77,239
29	$19,582	$58,500	$78,082
30	$20,464	$58,500	$78,964
31	$21,385	$58,500	$79,885
32	$22,347	$58,500	$80,847
33	$23,352	$58,500	$81,852
34	$24,403	$58,500	$82,903
35	$25,501	$58,500	$84,001
36	$26,649	$58,500	$85,149
37	$27,848	$58,500	$86,348
38	$29,101	$58,500	$87,601
39	$30,411	$58,500	$88,911
40	$31,779	$58,500	$90,279
		NPV =	***$877,911***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	6.00%
Cost/kWh	$0.06
Inflation rate	5.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,792	$58,500	$64,292
2	$6,082	$58,500	$64,582
3	$6,386	$58,500	$64,886
4	$6,705	$58,500	$65,205
5	$7,040	$58,500	$65,540
6	$7,392	$58,500	$65,892
7	$7,762	$58,500	$66,262
8	$8,150	$58,500	$66,650
9	$8,557	$58,500	$67,057
10	$8,985	$58,500	$67,485
11	$9,435	$58,500	$67,935
12	$9,906	$58,500	$68,406
13	$10,402	$58,500	$68,902
14	$10,922	$58,500	$69,422
15	$11,468	$58,500	$69,968
16	$12,041	$58,500	$70,541
17	$12,643	$58,500	$71,143
18	$13,275	$58,500	$71,775
19	$13,939	$58,500	$72,439
20	$14,636	$58,500	$73,136
21	$15,368	$58,500	$73,868
22	$16,136	$58,500	$74,636
23	$16,943	$58,500	$75,443
24	$17,790	$58,500	$76,290
25	$18,680	$58,500	$77,180
26	$19,614	$58,500	$78,114
27	$20,595	$58,500	$79,095
28	$21,624	$58,500	$80,124
29	$22,705	$58,500	$81,205
30	$23,841	$58,500	$82,341
31	$25,033	$58,500	$83,533
32	$26,284	$58,500	$84,784
33	$27,599	$58,500	$86,099
34	$28,979	$58,500	$87,479
35	$30,427	$58,500	$88,927
36	$31,949	$58,500	$90,449
37	$33,546	$58,500	$92,046
38	$35,224	$58,500	$93,724
39	$36,985	$58,500	$95,485
40	$38,834	$58,500	$97,334
		NPV =	***$892,498***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	7.00%
Cost/kWh	$0.06
Inflation rate	3.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,467	$58,500	$63,967
2	$5,631	$58,500	$64,131
3	$5,800	$58,500	$64,300
4	$5,974	$58,500	$64,474
5	$6,154	$58,500	$64,654
6	$6,338	$58,500	$64,838
7	$6,528	$58,500	$65,028
8	$6,724	$58,500	$65,224
9	$6,926	$58,500	$65,426
10	$7,134	$58,500	$65,634
11	$7,348	$58,500	$65,848
12	$7,568	$58,500	$66,068
13	$7,795	$58,500	$66,295
14	$8,029	$58,500	$66,529
15	$8,270	$58,500	$66,770
16	$8,518	$58,500	$67,018
17	$8,773	$58,500	$67,273
18	$9,037	$58,500	$67,537
19	$9,308	$58,500	$67,808
20	$9,587	$58,500	$68,087
21	$9,875	$58,500	$68,375
22	$10,171	$58,500	$68,671
23	$10,476	$58,500	$68,976
24	$10,790	$58,500	$69,290
25	$11,114	$58,500	$69,614
26	$11,447	$58,500	$69,947
27	$11,791	$58,500	$70,291
28	$12,144	$58,500	$70,644
29	$12,509	$58,500	$71,009
30	$12,884	$58,500	$71,384
31	$13,271	$58,500	$71,771
32	$13,669	$58,500	$72,169
33	$14,079	$58,500	$72,579
34	$14,501	$58,500	$73,001
35	$14,936	$58,500	$73,436
36	$15,384	$58,500	$73,884
37	$15,846	$58,500	$74,346
38	$16,321	$58,500	$74,821
39	$16,811	$58,500	$75,311
40	$17,315	$58,500	$75,815
		NPV =	***$723,903***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	7.00%
Cost/kWh	$0.06
Inflation rate	3.50%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,547	$58,500	$64,047
2	$5,741	$58,500	$64,241
3	$5,942	$58,500	$64,442
4	$6,150	$58,500	$64,650
5	$6,366	$58,500	$64,866
6	$6,588	$58,500	$65,088
7	$6,819	$58,500	$65,319
8	$7,058	$58,500	$65,558
9	$7,305	$58,500	$65,805
10	$7,560	$58,500	$66,060
11	$7,825	$58,500	$66,325
12	$8,099	$58,500	$66,599
13	$8,382	$58,500	$66,882
14	$8,676	$58,500	$67,176
15	$8,979	$58,500	$67,479
16	$9,294	$58,500	$67,794
17	$9,619	$58,500	$68,119
18	$9,956	$58,500	$68,456
19	$10,304	$58,500	$68,804
20	$10,665	$58,500	$69,165
21	$11,038	$58,500	$69,538
22	$11,424	$58,500	$69,924
23	$11,824	$58,500	$70,324
24	$12,238	$58,500	$70,738
25	$12,666	$58,500	$71,166
26	$13,110	$58,500	$71,610
27	$13,569	$58,500	$72,069
28	$14,043	$58,500	$72,543
29	$14,535	$58,500	$73,035
30	$15,044	$58,500	$73,544
31	$15,570	$58,500	$74,070
32	$16,115	$58,500	$74,615
33	$16,679	$58,500	$75,179
34	$17,263	$58,500	$75,763
35	$17,867	$58,500	$76,367
36	$18,492	$58,500	$76,992
37	$19,140	$58,500	$77,640
38	$19,810	$58,500	$78,310
39	$20,503	$58,500	$79,003
40	$21,221	$58,500	$79,721

NPV = $731,806

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	7.00%
Cost/kWh	$0.06
Inflation rate	4.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,628	$58,500	$64,128
2	$5,853	$58,500	$64,353
3	$6,087	$58,500	$64,587
4	$6,331	$58,500	$64,831
5	$6,584	$58,500	$65,084
6	$6,847	$58,500	$65,347
7	$7,121	$58,500	$65,621
8	$7,406	$58,500	$65,906
9	$7,702	$58,500	$66,202
10	$8,011	$58,500	$66,511
11	$8,331	$58,500	$66,831
12	$8,664	$58,500	$67,164
13	$9,011	$58,500	$67,511
14	$9,371	$58,500	$67,871
15	$9,746	$58,500	$68,246
16	$10,136	$58,500	$68,636
17	$10,541	$58,500	$69,041
18	$10,963	$58,500	$69,463
19	$11,401	$58,500	$69,901
20	$11,858	$58,500	$70,358
21	$12,332	$58,500	$70,832
22	$12,825	$58,500	$71,325
23	$13,338	$58,500	$71,838
24	$13,872	$58,500	$72,372
25	$14,427	$58,500	$72,927
26	$15,004	$58,500	$73,504
27	$15,604	$58,500	$74,104
28	$16,228	$58,500	$74,728
29	$16,877	$58,500	$75,377
30	$17,552	$58,500	$76,052
31	$18,254	$58,500	$76,754
32	$18,984	$58,500	$77,484
33	$19,744	$58,500	$78,244
34	$20,533	$58,500	$79,033
35	$21,355	$58,500	$79,855
36	$22,209	$58,500	$80,709
37	$23,097	$58,500	$81,597
38	$24,021	$58,500	$82,521
39	$24,982	$58,500	$83,482
40	$25,981	$58,500	$84,481

NPV = $740,676

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	7.00%
Cost/kWh	$0.06
Inflation rate	4.50%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,710	$58,500	$64,210
2	$5,967	$58,500	$64,467
3	$6,235	$58,500	$64,735
4	$6,516	$58,500	$65,016
5	$6,809	$58,500	$65,309
6	$7,115	$58,500	$65,615
7	$7,435	$58,500	$65,935
8	$7,770	$58,500	$66,270
9	$8,120	$58,500	$66,620
10	$8,485	$58,500	$66,985
11	$8,867	$58,500	$67,367
12	$9,266	$58,500	$67,766
13	$9,683	$58,500	$68,183
14	$10,119	$58,500	$68,619
15	$10,574	$58,500	$69,074
16	$11,050	$58,500	$69,550
17	$11,547	$58,500	$70,047
18	$12,067	$58,500	$70,567
19	$12,610	$58,500	$71,110
20	$13,177	$58,500	$71,677
21	$13,770	$58,500	$72,270
22	$14,390	$58,500	$72,890
23	$15,037	$58,500	$73,537
24	$15,714	$58,500	$74,214
25	$16,421	$58,500	$74,921
26	$17,160	$58,500	$75,660
27	$17,932	$58,500	$76,432
28	$18,739	$58,500	$77,239
29	$19,582	$58,500	$78,082
30	$20,464	$58,500	$78,964
31	$21,385	$58,500	$79,885
32	$22,347	$58,500	$80,847
33	$23,352	$58,500	$81,852
34	$24,403	$58,500	$82,903
35	$25,501	$58,500	$84,001
36	$26,649	$58,500	$85,149
37	$27,848	$58,500	$86,348
38	$29,101	$58,500	$87,601
39	$30,411	$58,500	$88,911
40	$31,779	$58,500	$90,279
		NPV =	***$750,653***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	7.00%
Cost/kWh	$0.06
Inflation rate	5.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,792	$58,500	$64,292
2	$6,082	$58,500	$64,582
3	$6,386	$58,500	$64,886
4	$6,705	$58,500	$65,205
5	$7,040	$58,500	$65,540
6	$7,392	$58,500	$65,892
7	$7,762	$58,500	$66,262
8	$8,150	$58,500	$66,650
9	$8,557	$58,500	$67,057
10	$8,985	$58,500	$67,485
11	$9,435	$58,500	$67,935
12	$9,906	$58,500	$68,406
13	$10,402	$58,500	$68,902
14	$10,922	$58,500	$69,422
15	$11,468	$58,500	$69,968
16	$12,041	$58,500	$70,541
17	$12,643	$58,500	$71,143
18	$13,275	$58,500	$71,775
19	$13,939	$58,500	$72,439
20	$14,636	$58,500	$73,136
21	$15,368	$58,500	$73,868
22	$16,136	$58,500	$74,636
23	$16,943	$58,500	$75,443
24	$17,790	$58,500	$76,290
25	$18,680	$58,500	$77,180
26	$19,614	$58,500	$78,114
27	$20,595	$58,500	$79,095
28	$21,624	$58,500	$80,124
29	$22,705	$58,500	$81,205
30	$23,841	$58,500	$82,341
31	$25,033	$58,500	$83,533
32	$26,284	$58,500	$84,784
33	$27,599	$58,500	$86,099
34	$28,979	$58,500	$87,479
35	$30,427	$58,500	$88,927
36	$31,949	$58,500	$90,449
37	$33,546	$58,500	$92,046
38	$35,224	$58,500	$93,724
39	$36,985	$58,500	$95,485
40	$38,834	$58,500	$97,334
		NPV =	***$761,896***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	8.00%
Cost/kWh	$0.06
Inflation rate	3.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,467	$58,500	$63,967
2	$5,631	$58,500	$64,131
3	$5,800	$58,500	$64,300
4	$5,974	$58,500	$64,474
5	$6,154	$58,500	$64,654
6	$6,338	$58,500	$64,838
7	$6,528	$58,500	$65,028
8	$6,724	$58,500	$65,224
9	$6,926	$58,500	$65,426
10	$7,134	$58,500	$65,634
11	$7,348	$58,500	$65,848
12	$7,568	$58,500	$66,068
13	$7,795	$58,500	$66,295
14	$8,029	$58,500	$66,529
15	$8,270	$58,500	$66,770
16	$8,518	$58,500	$67,018
17	$8,773	$58,500	$67,273
18	$9,037	$58,500	$67,537
19	$9,308	$58,500	$67,808
20	$9,587	$58,500	$68,087
21	$9,875	$58,500	$68,375
22	$10,171	$58,500	$68,671
23	$10,476	$58,500	$68,976
24	$10,790	$58,500	$69,290
25	$11,114	$58,500	$69,614
26	$11,447	$58,500	$69,947
27	$11,791	$58,500	$70,291
28	$12,144	$58,500	$70,644
29	$12,509	$58,500	$71,009
30	$12,884	$58,500	$71,384
31	$13,271	$58,500	$71,771
32	$13,669	$58,500	$72,169
33	$14,079	$58,500	$72,579
34	$14,501	$58,500	$73,001
35	$14,936	$58,500	$73,436
36	$15,384	$58,500	$73,884
37	$15,846	$58,500	$74,346
38	$16,321	$58,500	$74,821
39	$16,811	$58,500	$75,311
40	$17,315	$58,500	$75,815
		NPV =	***$627,538***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	8.00%
Cost/kWh	$0.06
Inflation rate	3.50%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,547	$58,500	$64,047
2	$5,741	$58,500	$64,241
3	$5,942	$58,500	$64,442
4	$6,150	$58,500	$64,650
5	$6,366	$58,500	$64,866
6	$6,588	$58,500	$65,088
7	$6,819	$58,500	$65,319
8	$7,058	$58,500	$65,558
9	$7,305	$58,500	$65,805
10	$7,560	$58,500	$66,060
11	$7,825	$58,500	$66,325
12	$8,099	$58,500	$66,599
13	$8,382	$58,500	$66,882
14	$8,676	$58,500	$67,176
15	$8,979	$58,500	$67,479
16	$9,294	$58,500	$67,794
17	$9,619	$58,500	$68,119
18	$9,956	$58,500	$68,456
19	$10,304	$58,500	$68,804
20	$10,665	$58,500	$69,165
21	$11,038	$58,500	$69,538
22	$11,424	$58,500	$69,924
23	$11,824	$58,500	$70,324
24	$12,238	$58,500	$70,738
25	$12,666	$58,500	$71,166
26	$13,110	$58,500	$71,610
27	$13,569	$58,500	$72,069
28	$14,043	$58,500	$72,543
29	$14,535	$58,500	$73,035
30	$15,044	$58,500	$73,544
31	$15,570	$58,500	$74,070
32	$16,115	$58,500	$74,615
33	$16,679	$58,500	$75,179
34	$17,263	$58,500	$75,763
35	$17,867	$58,500	$76,367
36	$18,492	$58,500	$76,992
37	$19,140	$58,500	$77,640
38	$19,810	$58,500	$78,310
39	$20,503	$58,500	$79,003
40	$21,221	$58,500	$79,721
		NPV =	***$633,793***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	8.00%
Cost/kWh	$0.06
Inflation rate	4.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,628	$58,500	$64,128
2	$5,853	$58,500	$64,353
3	$6,087	$58,500	$64,587
4	$6,331	$58,500	$64,831
5	$6,584	$58,500	$65,084
6	$6,847	$58,500	$65,347
7	$7,121	$58,500	$65,621
8	$7,406	$58,500	$65,906
9	$7,702	$58,500	$66,202
10	$8,011	$58,500	$66,511
11	$8,331	$58,500	$66,831
12	$8,664	$58,500	$67,164
13	$9,011	$58,500	$67,511
14	$9,371	$58,500	$67,871
15	$9,746	$58,500	$68,246
16	$10,136	$58,500	$68,636
17	$10,541	$58,500	$69,041
18	$10,963	$58,500	$69,463
19	$11,401	$58,500	$69,901
20	$11,858	$58,500	$70,358
21	$12,332	$58,500	$70,832
22	$12,825	$58,500	$71,325
23	$13,338	$58,500	$71,838
24	$13,872	$58,500	$72,372
25	$14,427	$58,500	$72,927
26	$15,004	$58,500	$73,504
27	$15,604	$58,500	$74,104
28	$16,228	$58,500	$74,728
29	$16,877	$58,500	$75,377
30	$17,552	$58,500	$76,052
31	$18,254	$58,500	$76,754
32	$18,984	$58,500	$77,484
33	$19,744	$58,500	$78,244
34	$20,533	$58,500	$79,033
35	$21,355	$58,500	$79,855
36	$22,209	$58,500	$80,709
37	$23,097	$58,500	$81,597
38	$24,021	$58,500	$82,521
39	$24,982	$58,500	$83,482
40	$25,981	$58,500	$84,481

NPV = $640,780

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	8.00%
Cost/kWh	$0.06
Inflation rate	4.50%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,710	$58,500	$64,210
2	$5,967	$58,500	$64,467
3	$6,235	$58,500	$64,735
4	$6,516	$58,500	$65,016
5	$6,809	$58,500	$65,309
6	$7,115	$58,500	$65,615
7	$7,435	$58,500	$65,935
8	$7,770	$58,500	$66,270
9	$8,120	$58,500	$66,620
10	$8,485	$58,500	$66,985
11	$8,867	$58,500	$67,367
12	$9,266	$58,500	$67,766
13	$9,683	$58,500	$68,183
14	$10,119	$58,500	$68,619
15	$10,574	$58,500	$69,074
16	$11,050	$58,500	$69,550
17	$11,547	$58,500	$70,047
18	$12,067	$58,500	$70,567
19	$12,610	$58,500	$71,110
20	$13,177	$58,500	$71,677
21	$13,770	$58,500	$72,270
22	$14,390	$58,500	$72,890
23	$15,037	$58,500	$73,537
24	$15,714	$58,500	$74,214
25	$16,421	$58,500	$74,921
26	$17,160	$58,500	$75,660
27	$17,932	$58,500	$76,432
28	$18,739	$58,500	$77,239
29	$19,582	$58,500	$78,082
30	$20,464	$58,500	$78,964
31	$21,385	$58,500	$79,885
32	$22,347	$58,500	$80,847
33	$23,352	$58,500	$81,852
34	$24,403	$58,500	$82,903
35	$25,501	$58,500	$84,001
36	$26,649	$58,500	$85,149
37	$27,848	$58,500	$86,348
38	$29,101	$58,500	$87,601
39	$30,411	$58,500	$88,911
40	$31,779	$58,500	$90,279
		NPV =	***$648,598***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	8.00%
Cost/kWh	$0.06
Inflation rate	5.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,792	$58,500	$64,292
2	$6,082	$58,500	$64,582
3	$6,386	$58,500	$64,886
4	$6,705	$58,500	$65,205
5	$7,040	$58,500	$65,540
6	$7,392	$58,500	$65,892
7	$7,762	$58,500	$66,262
8	$8,150	$58,500	$66,650
9	$8,557	$58,500	$67,057
10	$8,985	$58,500	$67,485
11	$9,435	$58,500	$67,935
12	$9,906	$58,500	$68,406
13	$10,402	$58,500	$68,902
14	$10,922	$58,500	$69,422
15	$11,468	$58,500	$69,968
16	$12,041	$58,500	$70,541
17	$12,643	$58,500	$71,143
18	$13,275	$58,500	$71,775
19	$13,939	$58,500	$72,439
20	$14,636	$58,500	$73,136
21	$15,368	$58,500	$73,868
22	$16,136	$58,500	$74,636
23	$16,943	$58,500	$75,443
24	$17,790	$58,500	$76,290
25	$18,680	$58,500	$77,180
26	$19,614	$58,500	$78,114
27	$20,595	$58,500	$79,095
28	$21,624	$58,500	$80,124
29	$22,705	$58,500	$81,205
30	$23,841	$58,500	$82,341
31	$25,033	$58,500	$83,533
32	$26,284	$58,500	$84,784
33	$27,599	$58,500	$86,099
34	$28,979	$58,500	$87,479
35	$30,427	$58,500	$88,927
36	$31,949	$58,500	$90,449
37	$33,546	$58,500	$92,046
38	$35,224	$58,500	$93,724
39	$36,985	$58,500	$95,485
40	$38,834	$58,500	$97,334
		NPV =	***$657,366***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	9.00%
Cost/kWh	$0.06
Inflation rate	3.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,467	$58,500	$63,967
2	$5,631	$58,500	$64,131
3	$5,800	$58,500	$64,300
4	$5,974	$58,500	$64,474
5	$6,154	$58,500	$64,654
6	$6,338	$58,500	$64,838
7	$6,528	$58,500	$65,028
8	$6,724	$58,500	$65,224
9	$6,926	$58,500	$65,426
10	$7,134	$58,500	$65,634
11	$7,348	$58,500	$65,848
12	$7,568	$58,500	$66,068
13	$7,795	$58,500	$66,295
14	$8,029	$58,500	$66,529
15	$8,270	$58,500	$66,770
16	$8,518	$58,500	$67,018
17	$8,773	$58,500	$67,273
18	$9,037	$58,500	$67,537
19	$9,308	$58,500	$67,808
20	$9,587	$58,500	$68,087
21	$9,875	$58,500	$68,375
22	$10,171	$58,500	$68,671
23	$10,476	$58,500	$68,976
24	$10,790	$58,500	$69,290
25	$11,114	$58,500	$69,614
26	$11,447	$58,500	$69,947
27	$11,791	$58,500	$70,291
28	$12,144	$58,500	$70,644
29	$12,509	$58,500	$71,009
30	$12,884	$58,500	$71,384
31	$13,271	$58,500	$71,771
32	$13,669	$58,500	$72,169
33	$14,079	$58,500	$72,579
34	$14,501	$58,500	$73,001
35	$14,936	$58,500	$73,436
36	$15,384	$58,500	$73,884
37	$15,846	$58,500	$74,346
38	$16,321	$58,500	$74,821
39	$16,811	$58,500	$75,311
40	$17,315	$58,500	$75,815
		NPV =	***$548,995***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	9.00%
Cost/kWh	$0.06
Inflation rate	3.50%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,547	$58,500	$64,047
2	$5,741	$58,500	$64,241
3	$5,942	$58,500	$64,442
4	$6,150	$58,500	$64,650
5	$6,366	$58,500	$64,866
6	$6,588	$58,500	$65,088
7	$6,819	$58,500	$65,319
8	$7,058	$58,500	$65,558
9	$7,305	$58,500	$65,805
10	$7,560	$58,500	$66,060
11	$7,825	$58,500	$66,325
12	$8,099	$58,500	$66,599
13	$8,382	$58,500	$66,882
14	$8,676	$58,500	$67,176
15	$8,979	$58,500	$67,479
16	$9,294	$58,500	$67,794
17	$9,619	$58,500	$68,119
18	$9,956	$58,500	$68,456
19	$10,304	$58,500	$68,804
20	$10,665	$58,500	$69,165
21	$11,038	$58,500	$69,538
22	$11,424	$58,500	$69,924
23	$11,824	$58,500	$70,324
24	$12,238	$58,500	$70,738
25	$12,666	$58,500	$71,166
26	$13,110	$58,500	$71,610
27	$13,569	$58,500	$72,069
28	$14,043	$58,500	$72,543
29	$14,535	$58,500	$73,035
30	$15,044	$58,500	$73,544
31	$15,570	$58,500	$74,070
32	$16,115	$58,500	$74,615
33	$16,679	$58,500	$75,179
34	$17,263	$58,500	$75,763
35	$17,867	$58,500	$76,367
36	$18,492	$58,500	$76,992
37	$19,140	$58,500	$77,640
38	$19,810	$58,500	$78,310
39	$20,503	$58,500	$79,003
40	$21,221	$58,500	$79,721

NPV = $554,005

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	9.00%
Cost/kWh	$0.06
Inflation rate	4.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,628	$58,500	$64,128
2	$5,853	$58,500	$64,353
3	$6,087	$58,500	$64,587
4	$6,331	$58,500	$64,831
5	$6,584	$58,500	$65,084
6	$6,847	$58,500	$65,347
7	$7,121	$58,500	$65,621
8	$7,406	$58,500	$65,906
9	$7,702	$58,500	$66,202
10	$8,011	$58,500	$66,511
11	$8,331	$58,500	$66,831
12	$8,664	$58,500	$67,164
13	$9,011	$58,500	$67,511
14	$9,371	$58,500	$67,871
15	$9,746	$58,500	$68,246
16	$10,136	$58,500	$68,636
17	$10,541	$58,500	$69,041
18	$10,963	$58,500	$69,463
19	$11,401	$58,500	$69,901
20	$11,858	$58,500	$70,358
21	$12,332	$58,500	$70,832
22	$12,825	$58,500	$71,325
23	$13,338	$58,500	$71,838
24	$13,872	$58,500	$72,372
25	$14,427	$58,500	$72,927
26	$15,004	$58,500	$73,504
27	$15,604	$58,500	$74,104
28	$16,228	$58,500	$74,728
29	$16,877	$58,500	$75,377
30	$17,552	$58,500	$76,052
31	$18,254	$58,500	$76,754
32	$18,984	$58,500	$77,484
33	$19,744	$58,500	$78,244
34	$20,533	$58,500	$79,033
35	$21,355	$58,500	$79,855
36	$22,209	$58,500	$80,709
37	$23,097	$58,500	$81,597
38	$24,021	$58,500	$82,521
39	$24,982	$58,500	$83,482
40	$25,981	$58,500	$84,481
		NPV =	***$559,572***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	9.00%
Cost/kWh	$0.06
Inflation rate	4.50%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,710	$58,500	$64,210
2	$5,967	$58,500	$64,467
3	$6,235	$58,500	$64,735
4	$6,516	$58,500	$65,016
5	$6,809	$58,500	$65,309
6	$7,115	$58,500	$65,615
7	$7,435	$58,500	$65,935
8	$7,770	$58,500	$66,270
9	$8,120	$58,500	$66,620
10	$8,485	$58,500	$66,985
11	$8,867	$58,500	$67,367
12	$9,266	$58,500	$67,766
13	$9,683	$58,500	$68,183
14	$10,119	$58,500	$68,619
15	$10,574	$58,500	$69,074
16	$11,050	$58,500	$69,550
17	$11,547	$58,500	$70,047
18	$12,067	$58,500	$70,567
19	$12,610	$58,500	$71,110
20	$13,177	$58,500	$71,677
21	$13,770	$58,500	$72,270
22	$14,390	$58,500	$72,890
23	$15,037	$58,500	$73,537
24	$15,714	$58,500	$74,214
25	$16,421	$58,500	$74,921
26	$17,160	$58,500	$75,660
27	$17,932	$58,500	$76,432
28	$18,739	$58,500	$77,239
29	$19,582	$58,500	$78,082
30	$20,464	$58,500	$78,964
31	$21,385	$58,500	$79,885
32	$22,347	$58,500	$80,847
33	$23,352	$58,500	$81,852
34	$24,403	$58,500	$82,903
35	$25,501	$58,500	$84,001
36	$26,649	$58,500	$85,149
37	$27,848	$58,500	$86,348
38	$29,101	$58,500	$87,601
39	$30,411	$58,500	$88,911
40	$31,779	$58,500	$90,279
		NPV =	***$565,772***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	9.00%
Cost/kWh	$0.06
Inflation rate	5.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,792	$58,500	$64,292
2	$6,082	$58,500	$64,582
3	$6,386	$58,500	$64,886
4	$6,705	$58,500	$65,205
5	$7,040	$58,500	$65,540
6	$7,392	$58,500	$65,892
7	$7,762	$58,500	$66,262
8	$8,150	$58,500	$66,650
9	$8,557	$58,500	$67,057
10	$8,985	$58,500	$67,485
11	$9,435	$58,500	$67,935
12	$9,906	$58,500	$68,406
13	$10,402	$58,500	$68,902
14	$10,922	$58,500	$69,422
15	$11,468	$58,500	$69,968
16	$12,041	$58,500	$70,541
17	$12,643	$58,500	$71,143
18	$13,275	$58,500	$71,775
19	$13,939	$58,500	$72,439
20	$14,636	$58,500	$73,136
21	$15,368	$58,500	$73,868
22	$16,136	$58,500	$74,636
23	$16,943	$58,500	$75,443
24	$17,790	$58,500	$76,290
25	$18,680	$58,500	$77,180
26	$19,614	$58,500	$78,114
27	$20,595	$58,500	$79,095
28	$21,624	$58,500	$80,124
29	$22,705	$58,500	$81,205
30	$23,841	$58,500	$82,341
31	$25,033	$58,500	$83,533
32	$26,284	$58,500	$84,784
33	$27,599	$58,500	$86,099
34	$28,979	$58,500	$87,479
35	$30,427	$58,500	$88,927
36	$31,949	$58,500	$90,449
37	$33,546	$58,500	$92,046
38	$35,224	$58,500	$93,724
39	$36,985	$58,500	$95,485
40	$38,834	$58,500	$97,334

NPV = $572,691

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	10.00%
Cost/kWh	$0.06
Inflation rate	3.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,467	$58,500	$63,967
2	$5,631	$58,500	$64,131
3	$5,800	$58,500	$64,300
4	$5,974	$58,500	$64,474
5	$6,154	$58,500	$64,654
6	$6,338	$58,500	$64,838
7	$6,528	$58,500	$65,028
8	$6,724	$58,500	$65,224
9	$6,926	$58,500	$65,426
10	$7,134	$58,500	$65,634
11	$7,348	$58,500	$65,848
12	$7,568	$58,500	$66,068
13	$7,795	$58,500	$66,295
14	$8,029	$58,500	$66,529
15	$8,270	$58,500	$66,770
16	$8,518	$58,500	$67,018
17	$8,773	$58,500	$67,273
18	$9,037	$58,500	$67,537
19	$9,308	$58,500	$67,808
20	$9,587	$58,500	$68,087
21	$9,875	$58,500	$68,375
22	$10,171	$58,500	$68,671
23	$10,476	$58,500	$68,976
24	$10,790	$58,500	$69,290
25	$11,114	$58,500	$69,614
26	$11,447	$58,500	$69,947
27	$11,791	$58,500	$70,291
28	$12,144	$58,500	$70,644
29	$12,509	$58,500	$71,009
30	$12,884	$58,500	$71,384
31	$13,271	$58,500	$71,771
32	$13,669	$58,500	$72,169
33	$14,079	$58,500	$72,579
34	$14,501	$58,500	$73,001
35	$14,936	$58,500	$73,436
36	$15,384	$58,500	$73,884
37	$15,846	$58,500	$74,346
38	$16,321	$58,500	$74,821
39	$16,811	$58,500	$75,311
40	$17,315	$58,500	$75,815

NPV = ***$484,260***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	10.00%
Cost/kWh	$0.06
Inflation rate	3.50%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,547	$58,500	$64,047
2	$5,741	$58,500	$64,241
3	$5,942	$58,500	$64,442
4	$6,150	$58,500	$64,650
5	$6,366	$58,500	$64,866
6	$6,588	$58,500	$65,088
7	$6,819	$58,500	$65,319
8	$7,058	$58,500	$65,558
9	$7,305	$58,500	$65,805
10	$7,560	$58,500	$66,060
11	$7,825	$58,500	$66,325
12	$8,099	$58,500	$66,599
13	$8,382	$58,500	$66,882
14	$8,676	$58,500	$67,176
15	$8,979	$58,500	$67,479
16	$9,294	$58,500	$67,794
17	$9,619	$58,500	$68,119
18	$9,956	$58,500	$68,456
19	$10,304	$58,500	$68,804
20	$10,665	$58,500	$69,165
21	$11,038	$58,500	$69,538
22	$11,424	$58,500	$69,924
23	$11,824	$58,500	$70,324
24	$12,238	$58,500	$70,738
25	$12,666	$58,500	$71,166
26	$13,110	$58,500	$71,610
27	$13,569	$58,500	$72,069
28	$14,043	$58,500	$72,543
29	$14,535	$58,500	$73,035
30	$15,044	$58,500	$73,544
31	$15,570	$58,500	$74,070
32	$16,115	$58,500	$74,615
33	$16,679	$58,500	$75,179
34	$17,263	$58,500	$75,763
35	$17,867	$58,500	$76,367
36	$18,492	$58,500	$76,992
37	$19,140	$58,500	$77,640
38	$19,810	$58,500	$78,310
39	$20,503	$58,500	$79,003
40	$21,221	$58,500	$79,721

NPV = $488,319

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	10.00%
Cost/kWh	$0.06
Inflation rate	4.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,628	$58,500	$64,128
2	$5,853	$58,500	$64,353
3	$6,087	$58,500	$64,587
4	$6,331	$58,500	$64,831
5	$6,584	$58,500	$65,084
6	$6,847	$58,500	$65,347
7	$7,121	$58,500	$65,621
8	$7,406	$58,500	$65,906
9	$7,702	$58,500	$66,202
10	$8,011	$58,500	$66,511
11	$8,331	$58,500	$66,831
12	$8,664	$58,500	$67,164
13	$9,011	$58,500	$67,511
14	$9,371	$58,500	$67,871
15	$9,746	$58,500	$68,246
16	$10,136	$58,500	$68,636
17	$10,541	$58,500	$69,041
18	$10,963	$58,500	$69,463
19	$11,401	$58,500	$69,901
20	$11,858	$58,500	$70,358
21	$12,332	$58,500	$70,832
22	$12,825	$58,500	$71,325
23	$13,338	$58,500	$71,838
24	$13,872	$58,500	$72,372
25	$14,427	$58,500	$72,927
26	$15,004	$58,500	$73,504
27	$15,604	$58,500	$74,104
28	$16,228	$58,500	$74,728
29	$16,877	$58,500	$75,377
30	$17,552	$58,500	$76,052
31	$18,254	$58,500	$76,754
32	$18,984	$58,500	$77,484
33	$19,744	$58,500	$78,244
34	$20,533	$58,500	$79,033
35	$21,355	$58,500	$79,855
36	$22,209	$58,500	$80,709
37	$23,097	$58,500	$81,597
38	$24,021	$58,500	$82,521
39	$24,982	$58,500	$83,482
40	$25,981	$58,500	$84,481
		NPV =	***$492,807***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	10.00%
Cost/kWh	$0.06
Inflation rate	4.50%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,710	$58,500	$64,210
2	$5,967	$58,500	$64,467
3	$6,235	$58,500	$64,735
4	$6,516	$58,500	$65,016
5	$6,809	$58,500	$65,309
6	$7,115	$58,500	$65,615
7	$7,435	$58,500	$65,935
8	$7,770	$58,500	$66,270
9	$8,120	$58,500	$66,620
10	$8,485	$58,500	$66,985
11	$8,867	$58,500	$67,367
12	$9,266	$58,500	$67,766
13	$9,683	$58,500	$68,183
14	$10,119	$58,500	$68,619
15	$10,574	$58,500	$69,074
16	$11,050	$58,500	$69,550
17	$11,547	$58,500	$70,047
18	$12,067	$58,500	$70,567
19	$12,610	$58,500	$71,110
20	$13,177	$58,500	$71,677
21	$13,770	$58,500	$72,270
22	$14,390	$58,500	$72,890
23	$15,037	$58,500	$73,537
24	$15,714	$58,500	$74,214
25	$16,421	$58,500	$74,921
26	$17,160	$58,500	$75,660
27	$17,932	$58,500	$76,432
28	$18,739	$58,500	$77,239
29	$19,582	$58,500	$78,082
30	$20,464	$58,500	$78,964
31	$21,385	$58,500	$79,885
32	$22,347	$58,500	$80,847
33	$23,352	$58,500	$81,852
34	$24,403	$58,500	$82,903
35	$25,501	$58,500	$84,001
36	$26,649	$58,500	$85,149
37	$27,848	$58,500	$86,348
38	$29,101	$58,500	$87,601
39	$30,411	$58,500	$88,911
40	$31,779	$58,500	$90,279
		NPV =	***$497,780***

TABLE 7.2 (Continued)

SINNISSIPPI DAM

Savings to the City of Rock Falls due the Elimination of Flashboards

Discount rate	10.00%
Cost/kWh	$0.06
Inflation rate	5.00%
Energy lost due to insufficient head/flow caused by flashboards failure	975,000 kWh/year

YEAR	Total Labor & Material Cost to Build & Install the Flashboards	Total Lost Generating Revenue due to Flashboards	Total Expenditure/Lost Revenues because of Flashboards
1	$5,792	$58,500	$64,292
2	$6,082	$58,500	$64,582
3	$6,386	$58,500	$64,886
4	$6,705	$58,500	$65,205
5	$7,040	$58,500	$65,540
6	$7,392	$58,500	$65,892
7	$7,762	$58,500	$66,262
8	$8,150	$58,500	$66,650
9	$8,557	$58,500	$67,057
10	$8,985	$58,500	$67,485
11	$9,435	$58,500	$67,935
12	$9,906	$58,500	$68,406
13	$10,402	$58,500	$68,902
14	$10,922	$58,500	$69,422
15	$11,468	$58,500	$69,968
16	$12,041	$58,500	$70,541
17	$12,643	$58,500	$71,143
18	$13,275	$58,500	$71,775
19	$13,939	$58,500	$72,439
20	$14,636	$58,500	$73,136
21	$15,368	$58,500	$73,868
22	$16,136	$58,500	$74,636
23	$16,943	$58,500	$75,443
24	$17,790	$58,500	$76,290
25	$18,680	$58,500	$77,180
26	$19,614	$58,500	$78,114
27	$20,595	$58,500	$79,095
28	$21,624	$58,500	$80,124
29	$22,705	$58,500	$81,205
30	$23,841	$58,500	$82,341
31	$25,033	$58,500	$83,533
32	$26,284	$58,500	$84,784
33	$27,599	$58,500	$86,099
34	$28,979	$58,500	$87,479
35	$30,427	$58,500	$88,927
36	$31,949	$58,500	$90,449
37	$33,546	$58,500	$92,046
38	$35,224	$58,500	$93,724
39	$36,985	$58,500	$95,485
40	$38,834	$58,500	$97,334
		NPV =	***$503,303***

TABLE 7.3

FEASIBILITY STUDY FOR THE REHABILITATION OR RECONSTRUCTION OF SINNISSIPPI DAM

COST ESTIMATE

SUMMARY

	INITIAL CONSTRUCTION COST			NPV Including Initial Capital Investment & Future Maintenance		
	COST	% Greater than Lowest Cost Alternative	% Greater than Next Lowest Cost Alternative	COST	% Greater than Lowest Cost Alternative	% Greater than Next Lowest Cost Alternative
ALTERNATIVE 1 Pneumatically Operated Hinged-leaf Gates with Conventional Concrete Spillway & Removing the Existing P.H.	$6,664,867	8.61%	7.08%	$7,205,026	9.14%	6.51%
ALTERNATIVE 2 Pneumatically Operated Hinged-leaf Gates with Conventional Concrete Spillway, and Jet-grouting of the Existing P.H.	$6,136,625	0.00%	0.00%	$6,601,893	0.00%	0.00%
ALTERNATIVE 3 Pneumatically Operated Hinged-leaf Gates with Roller Compacted Concrete Spillway & Removing the Existing P.H.	$6,224,242	1.43%	1.43%	$6,764,401	2.46%	2.46%
ALTERNATIVE 4 Hydraulic Cylinder Operated Hinged-leaf Gates with Conventional Concrete Spillway & Removing the Existing P.H.	$8,150,406	32.82%	5.84%	$8,544,243	29.42%	5.56%
ALTERNATIVE 5 Hydraulic Cyl. Operated Hinged-leaf Gates with Conventional Concrete Spillway, and Jet-grouting of the Existing P.H.	$7,590,217	23.69%	13.88%	$7,984,054	20.94%	10.81%
ALTERNATIVE 6 Hydraulic Cylinder Operated Hinged-leaf Gates with Roller Compacted Concrete Spillway & Removing the Existing P.H.	$7,700,406	25.48%	1.45%	$8,094,243	22.60%	1.38%

TABLE 7.4

FEASIBLITY STUDY FOR THE REHABILITATION OR RECONSTRUCTION OF SINNISSIPPI DAM

COST ESTIMATE

NO	ITEM	UNIT	UNIT PRICE	ALTERNATIVE 1		ALTERNATIVE 2		ALTERNATIVE 3		ALTERNATIVE 4		ALTERNATIVE 5		ALTERNATIVE 6	
				QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST
1	**Mobilization/Demobilization**	LS	$200,000.00	1	$200,000	1	$200,000	1	$200,000	1	$200,000	1	$200,000	1	$200,000
2	**Earthfill Cofferdam**														
a	Upstream	CY	$18.75	1,800	$33,750			1,800	$33,750	1,800	$33,750			1,800	$33,750
b	Downstream	CY	$18.75	22,425	$420,469	22,200	$416,250	22,425	$420,469	22,200	$416,250	22,125	$414,844	22,200	$416,250
3	**Steel Sheet Pile Cofferdam**														
a	Downstream	SF	$25.00	2,500	$62,500	2,500	$62,500	2,500	$62,500	2,500	$62,500	2,500	$62,500	2,500	$62,500
4	**Demolition & Removal**														
a	Concrete, gates & crib dam	CY	$75.00	3,200	$240,000	3,350	$251,250	3,200	$240,000	3,130	$234,750	3,160	$237,000	3,130	$234,750
b	Steel gates/hoist assembly	LS	$50,000.00	1	$50,000	1	$50,000	1	$50,000	1	$50,000	1	$50,000	1	$50,000
c	Walkway/grating	SF	$15.00	2,050	$30,750	2,050	$30,750	2,050	$30,750	2,050	$30,750	2,050	$30,750	2,050	$30,750
d	Concrete, aban. P.H.	CY	$50.00	2,840	$142,000			2,840	$142,000	2,840	$142,000			2,840	$142,000
e	Fill, abandoned P.H.	CY	$12.50	15,230	$190,375			15,230	$190,375	15,230	$190,375			15,230	$190,375
5	**Excavation (Rock)**	CY	$30.00	675	$20,250	695	$20,850	675	$20,250	3,680	$110,400	3,765	$112,950	3,680	$110,400
6	**Concrete**														
a	Piers, reinforced	CY	$350.00	1,470	$514,500	1,175	$411,250	1,470	$514,500	1,610	$563,500	1,275	$446,250	1,610	$563,500
b	Foundation, reinforced	CY	$275.00	2,570	$706,750	2,650	$728,750	2,570	$706,750	3,700	$1,017,500	3,800	$1,045,000	3,700	$1,017,500
c	Cut-off walls	CY	$400.00	85	$34,000			85	$34,000	85	$34,000			85	$34,000
d	Ogee, mass	CY	$150.00	4,700	$705,000	2,575	$386,250			4,800	$720,000	2,650	$397,500		
e	RCC	CY	$60.00					5,875	$352,500					6,000	$360,000
f	Jet-grouted cut-off	LS	$300,000.00			1	$300,000					1	$300,000		
7	**Prefabricated Bridge**	SF	$50.00	7,200	$360,000	7,250	$362,500	7,200	$360,000	7,000	$350,000	7,150	$357,500	7,000	$350,000
8	**Gates**														
a	Pneumatically operated	SF	$230.00	5,685	$1,307,550	5,865	$1,348,950	5,685	$1,307,550						
b	Hydraulic cylinder operated	SF	$358.00							5,725	$2,049,550	5,860	$2,097,880	5,725	$2,049,550
c	Floating maint. bulkheads	LS		1	$134,000	1	$200,000	1	$134,000	1	$175,000	1	$180,000	1	$175,000
9	**Heaters**														
a	Abutment-type	EA	$10,000.00	18	$180,000	14	$140,000	18	$180,000	14	$140,000	14	$140,000	14	$140,000
10	**Contingencies**	LS @	25.00%		$1,332,973		$1,227,325		$1,244,848		$1,630,081		$1,518,043		$1,540,081
	TOTAL				**$6,664,867**		**$6,136,625**		**$6,224,242**		**$8,150,406**		**$7,590,217**		**$7,700,406**

Discount rate=	8.00%	Inflation rate=	4.00%
Cost/kWh=	$0.10	Heat days/yr=	90
Abut htr kW=	4		

TABLE 7.5

LIFE-CYCLE COST ANALYSIS

YEAR		1	2	3	4	5	6	7	8	9	10
Alternative 1:											
Initial cost	$6,664,867										
Maintenance											$25,246
Ice Suppression Electricity		$16,174	$16,821	$17,494	$18,194	$18,921	$19,678	$20,465	$21,284	$22,135	$23,021
Net cash flow (out)	$6,664,867	$16,174	$16,821	$17,494	$18,194	$18,921	$19,678	$20,465	$21,284	$22,135	$48,266
NPV = **$7,205,026**											
Alternative 2:											
Initial cost	$6,136,625										
Maintenance											$26,045
Ice Suppression Electricity		$12,580	$13,083	$13,606	$14,151	$14,717	$15,305	$15,918	$16,554	$17,216	$17,905
Net cash flow (out)	$6,136,625	$12,580	$13,083	$13,606	$14,151	$14,717	$15,305	$15,918	$16,554	$17,216	$43,950
NPV = **$6,601,893**											
Alternative 3:											
Initial cost	$6,224,242										
Maintenance											$25,246
Ice Suppression Electricity		$16,174	$16,821	$17,494	$18,194	$18,921	$19,678	$20,465	$21,284	$22,135	$23,021
Net cash flow (out)	$6,224,242	$16,174	$16,821	$17,494	$18,194	$18,921	$19,678	$20,465	$21,284	$22,135	$48,266
NPV = **$6,764,401**											
Alternative 4:											
Initial cost	$8,150,406										
Maintenance		$5,000	$5,200	$5,408	$5,624	$5,849	$6,083	$6,327	$6,580	$6,843	$7,117
Ice Suppression Electricity		$12,580	$13,083	$13,606	$14,151	$14,717	$15,305	$15,918	$16,554	$17,216	$17,905
Net cash flow (out)	$8,150,406	$17,580	$18,283	$19,014	$19,775	$20,566	$21,389	$22,244	$23,134	$24,059	$25,022
NPV = **$8,544,243**											
Alternative 5:											
Initial cost	$7,590,217										
Maintenance		$5,000	$5,200	$5,408	$5,624	$5,849	$6,083	$6,327	$6,580	$6,843	$7,117
Ice Suppression Electricity		$12,580	$13,083	$13,606	$14,151	$14,717	$15,305	$15,918	$16,554	$17,216	$17,905
Net cash flow (out)	$7,590,217	$17,580	$18,283	$19,014	$19,775	$20,566	$21,389	$22,244	$23,134	$24,059	$25,022
NPV = **$7,984,054**											
Alternative 6:											
Initial cost	$7,700,406										
Maintenance		$5,000	$5,200	$5,408	$5,624	$5,849	$6,083	$6,327	$6,580	$6,843	$7,117
Ice Suppression Electricity		$12,580	$13,083	$13,606	$14,151	$14,717	$15,305	$15,918	$16,554	$17,216	$17,905
Net cash flow (out)	$7,700,406	$17,580	$18,283	$19,014	$19,775	$20,566	$21,389	$22,244	$23,134	$24,059	$25,022
NPV = **$8,094,243**											

Discount rate=	8.00%	Inflation rate=	4.00%
Cost/kWh=	$0.10	Heat days/yr=	90
Abut htr kW=	4		

TABLE 7.5 (Continued)

LIFE-CYCLE COST ANALYSIS

YEAR		11	12	13	14	15	16	17	18	19	20
Alternative 1:											
Initial cost	$6,664,867										
Maintenance											$37,370
Ice Suppression Electricity		$23,942	$24,899	$25,895	$26,931	$28,008	$29,129	$30,294	$31,505	$32,766	$34,076
Net cash flow (out)	$6,664,867	$23,942	$24,899	$25,895	$26,931	$28,008	$29,129	$30,294	$31,505	$32,766	$71,446
NPV = **$7,205,026**											
Alternative 2:											
Initial cost	$6,136,625										
Maintenance											$38,553
Ice Suppression Electricity		$18,621	$19,366	$20,141	$20,946	$21,784	$22,656	$23,562	$24,504	$25,484	$26,504
Net cash flow (out)	$6,136,625	$18,621	$19,366	$20,141	$20,946	$21,784	$22,656	$23,562	$24,504	$25,484	$65,057
NPV = **$6,601,893**											
Alternative 3:											
Initial cost	$6,224,242										
Maintenance											$37,370
Ice Suppression Electricity		$23,942	$24,899	$25,895	$26,931	$28,008	$29,129	$30,294	$31,505	$32,766	$34,076
Net cash flow (out)	$6,224,242	$23,942	$24,899	$25,895	$26,931	$28,008	$29,129	$30,294	$31,505	$32,766	$71,446
NPV = **$6,764,401**											
Alternative 4:											
Initial cost	$8,150,406										
Maintenance		$7,401	$7,697	$8,005	$8,325	$8,658	$9,005	$9,365	$9,740	$10,129	$10,534
Ice Suppression Electricity		$18,621	$19,366	$20,141	$20,946	$21,784	$22,656	$23,562	$24,504	$25,484	$26,504
Net cash flow (out)	$8,150,406	$26,022	$27,063	$28,146	$29,272	$30,443	$31,660	$32,927	$34,244	$35,614	$37,038
NPV = **$8,544,243**											
Alternative 5:											
Initial cost	$7,590,217										
Maintenance		$7,401	$7,697	$8,005	$8,325	$8,658	$9,005	$9,365	$9,740	$10,129	$10,534
Ice Suppression Electricity		$18,621	$19,366	$20,141	$20,946	$21,784	$22,656	$23,562	$24,504	$25,484	$26,504
Net cash flow (out)	$7,590,217	$26,022	$27,063	$28,146	$29,272	$30,443	$31,660	$32,927	$34,244	$35,614	$37,038
NPV = **$7,984,054**											
Alternative 6:											
Initial cost	$7,700,406										
Maintenance		$7,401	$7,697	$8,005	$8,325	$8,658	$9,005	$9,365	$9,740	$10,129	$10,534
Ice Suppression Electricity		$18,621	$19,366	$20,141	$20,946	$21,784	$22,656	$23,562	$24,504	$25,484	$26,504
Net cash flow (out)	$7,700,406	$26,022	$27,063	$28,146	$29,272	$30,443	$31,660	$32,927	$34,244	$35,614	$37,038
NPV = **$8,094,243**											

Discount rate= 8.00%
Cost/kWh= $0.10
Abut htr kW= 4
Inflation rate= 4.00%
Heat days/yr= 90

TABLE 7.5 (Continued)

LIFE-CYCLE COST ANALYSIS

	YEAR	21	22	23	24	25	26	27	28	29	30
Alternative 1:											
Initial cost	$6,664,867										
Maintenance											$55,316
Ice Suppression Electricity		$35,439	$36,857	$38,331	$39,865	$41,459	$43,117	$44,842	$46,636	$48,501	$50,441
Net cash flow (out)	$6,664,867	$35,439	$36,857	$38,331	$39,865	$41,459	$43,117	$44,842	$46,636	$48,501	$105,757
NPV = **$7,205,026**											
Alternative 2:											
Initial cost	$6,136,625										
Maintenance											$57,068
Ice Suppression Electricity		$27,564	$28,667	$29,813	$31,006	$32,246	$33,536	$34,877	$36,272	$37,723	$39,232
Net cash flow (out)	$6,136,625	$27,564	$28,667	$29,813	$31,006	$32,246	$33,536	$34,877	$36,272	$37,723	$96,300
NPV = **$6,601,893**											
Alternative 3:											
Initial cost	$6,224,242										
Maintenance											$55,316
Ice Suppression Electricity		$35,439	$36,857	$38,331	$39,865	$41,459	$43,117	$44,842	$46,636	$48,501	$50,441
Net cash flow (out)	$6,224,242	$35,439	$36,857	$38,331	$39,865	$41,459	$43,117	$44,842	$46,636	$48,501	$105,757
NPV = **$6,764,401**											
Alternative 4:											
Initial cost	$8,150,406										
Maintenance		$10,956	$11,394	$11,850	$12,324	$12,817	$13,329	$13,862	$14,417	$14,994	$15,593
Ice Suppression Electricity		$27,564	$28,667	$29,813	$31,006	$32,246	$33,536	$34,877	$36,272	$37,723	$39,232
Net cash flow (out)	$8,150,406	$38,520	$40,060	$41,663	$43,329	$45,062	$46,865	$48,740	$50,689	$52,717	$54,825
NPV = **$8,544,243**											
Alternative 5:											
Initial cost	$7,590,217										
Maintenance		$10,956	$11,394	$11,850	$12,324	$12,817	$13,329	$13,862	$14,417	$14,994	$15,593
Ice Suppression Electricity		$27,564	$28,667	$29,813	$31,006	$32,246	$33,536	$34,877	$36,272	$37,723	$39,232
Net cash flow (out)	$7,590,217	$38,520	$40,060	$41,663	$43,329	$45,062	$46,865	$48,740	$50,689	$52,717	$54,825
NPV = **$7,984,054**											
Alternative 6:											
Initial cost	$7,700,406										
Maintenance		$10,956	$11,394	$11,850	$12,324	$12,817	$13,329	$13,862	$14,417	$14,994	$15,593
Ice Suppression Electricity		$27,564	$28,667	$29,813	$31,006	$32,246	$33,536	$34,877	$36,272	$37,723	$39,232
Net cash flow (out)	$7,700,406	$38,520	$40,060	$41,663	$43,329	$45,062	$46,865	$48,740	$50,689	$52,717	$54,825
NPV = **$8,094,243**											

Discount rate=	8.00%	Inflation rate=	4.00%
Cost/kWh=	$0.10	Heat days/yr=	90
Abut htr kW=	4		

TABLE 7.5 (Continued)

LIFE-CYCLE COST ANALYSIS

YEAR		31	32	33	34	35	36	37	38	39	40
Alternative 1:											
Initial cost	$6,664,867										
Maintenance											$3,220,669
Ice Suppression Electricity		$52,459	$54,557	$56,740	$59,009	$61,370	$63,824	$66,377	$69,032	$71,794	$74,665
Net cash flow (out)	$6,664,867	$52,459	$54,557	$56,740	$59,009	$61,370	$63,824	$66,377	$69,032	$71,794	$3,295,334
NPV = **$7,205,026**											
Alternative 2:											
Initial cost	$6,136,625										
Maintenance											$3,322,642
Ice Suppression Electricity		$40,801	$42,433	$44,131	$45,896	$47,732	$49,641	$51,627	$53,692	$55,840	$58,073
Net cash flow (out)	$6,136,625	$40,801	$42,433	$44,131	$45,896	$47,732	$49,641	$51,627	$53,692	$55,840	$3,380,715
NPV = **$6,601,893**											
Alternative 3:											
Initial cost	$6,224,242										
Maintenance											$3,220,669
Ice Suppression Electricity		$52,459	$54,557	$56,740	$59,009	$61,370	$63,824	$66,377	$69,032	$71,794	$74,665
Net cash flow (out)	$6,224,242	$52,459	$54,557	$56,740	$59,009	$61,370	$63,824	$66,377	$69,032	$71,794	$3,295,334
NPV = **$6,764,401**											
Alternative 4:											
Initial cost	$8,150,406										
Maintenance		$16,217	$16,866	$17,540	$18,242	$18,972	$19,730	$20,520	$21,340	$22,194	$23,082
Ice Suppression Electricity		$40,801	$42,433	$44,131	$45,896	$47,732	$49,641	$51,627	$53,692	$55,840	$58,073
Net cash flow (out)	$8,150,406	$57,018	$59,299	$61,671	$64,138	$66,703	$69,372	$72,146	$75,032	$78,034	$81,155
NPV = **$8,544,243**											
Alternative 5:											
Initial cost	$7,590,217										
Maintenance		$16,217	$16,866	$17,540	$18,242	$18,972	$19,730	$20,520	$21,340	$22,194	$23,082
Ice Suppression Electricity		$40,801	$42,433	$44,131	$45,896	$47,732	$49,641	$51,627	$53,692	$55,840	$58,073
Net cash flow (out)	$7,590,217	$57,018	$59,299	$61,671	$64,138	$66,703	$69,372	$72,146	$75,032	$78,034	$81,155
NPV = **$7,984,054**											
Alternative 6:											
Initial cost	$7,700,406										
Maintenance		$16,217	$16,866	$17,540	$18,242	$18,972	$19,730	$20,520	$21,340	$22,194	$23,082
Ice Suppression Electricity		$40,801	$42,433	$44,131	$45,896	$47,732	$49,641	$51,627	$53,692	$55,840	$58,073
Net cash flow (out)	$7,700,406	$57,018	$59,299	$61,671	$64,138	$66,703	$69,372	$72,146	$75,032	$78,034	$81,155
NPV = **$8,094,243**											

Discount rate=	8.00%	Inflation rate=	4.00%
Cost/kWh=	$0.10	Heat days/yr=	90
Abut htr kW=	4		

TABLE 7.5 (Continued)

LIFE-CYCLE COST ANALYSIS

YEAR		41	42	43	44	45	46	47	48	49	50
Alternative 1:											
Initial cost	$6,664,867										
Maintenance											$121,204
Ice Suppression Electricity		$77,652	$80,758	$83,989	$87,348	$90,842	$94,476	$98,255	$102,185	$106,272	$110,523
Net cash flow (out)	$6,664,867	$77,652	$80,758	$83,989	$87,348	$90,842	$94,476	$98,255	$102,185	$106,272	$231,728
NPV = **$7,205,026**											
Alternative 2:											
Initial cost	$6,136,625										
Maintenance											$125,042
Ice Suppression Electricity		$60,396	$62,812	$65,324	$67,937	$70,655	$73,481	$76,420	$79,477	$82,656	$85,962
Net cash flow (out)	$6,136,625	$60,396	$62,812	$65,324	$67,937	$70,655	$73,481	$76,420	$79,477	$82,656	$211,005
NPV = **$6,601,893**											
Alternative 3:											
Initial cost	$6,224,242										
Maintenance											$121,204
Ice Suppression Electricity		$77,652	$80,758	$83,989	$87,348	$90,842	$94,476	$98,255	$102,185	$106,272	$110,523
Net cash flow (out)	$6,224,242	$77,652	$80,758	$83,989	$87,348	$90,842	$94,476	$98,255	$102,185	$106,272	$231,728
NPV = **$6,764,401**											
Alternative 4:											
Initial cost	$8,150,406										
Maintenance		$24,005	$24,965	$25,964	$27,002	$28,083	$29,206	$30,374	$31,589	$32,853	$34,167
Ice Suppression Electricity		$60,396	$62,812	$65,324	$67,937	$70,655	$73,481	$76,420	$79,477	$82,656	$85,962
Net cash flow (out)	$8,150,406	$84,401	$87,777	$91,288	$94,940	$98,737	$102,687	$106,794	$111,066	$115,509	$120,129
NPV = **$8,544,243**											
Alternative 5:											
Initial cost	$7,590,217										
Maintenance		$24,005	$24,965	$25,964	$27,002	$28,083	$29,206	$30,374	$31,589	$32,853	$34,167
Ice Suppression Electricity		$60,396	$62,812	$65,324	$67,937	$70,655	$73,481	$76,420	$79,477	$82,656	$85,962
Net cash flow (out)	$7,590,217	$84,401	$87,777	$91,288	$94,940	$98,737	$102,687	$106,794	$111,066	$115,509	$120,129
NPV = **$7,984,054**											
Alternative 6:											
Initial cost	$7,700,406										
Maintenance		$24,005	$24,965	$25,964	$27,002	$28,083	$29,206	$30,374	$31,589	$32,853	$34,167
Ice Suppression Electricity		$60,396	$62,812	$65,324	$67,937	$70,655	$73,481	$76,420	$79,477	$82,656	$85,962
Net cash flow (out)	$7,700,406	$84,401	$87,777	$91,288	$94,940	$98,737	$102,687	$106,794	$111,066	$115,509	$120,129
NPV = **$8,094,243**											

Discount rate=	8.00%	Inflation rate=	4.00%
Cost/kWh=	$0.10	Heat days/yr=	90
Abut htr kW=	4		

TABLE 7.5 (Continued)

LIFE-CYCLE COST ANALYSIS

	YEAR	51	52	53	54	55	56	57	58	59	60
Alternative 1:											
Initial cost	$6,664,867										
Maintenance											$179,412
Ice Suppression Electricity		$114,944	$119,542	$124,324	$129,296	$134,468	$139,847	$145,441	$151,259	$157,309	$163,601
Net cash flow (out)	$6,664,867	$114,944	$119,542	$124,324	$129,296	$134,468	$139,847	$145,441	$151,259	$157,309	$343,013
NPV = **$7,205,026**											
Alternative 2:											
Initial cost	$6,136,625										
Maintenance											$185,093
Ice Suppression Electricity		$89,401	$92,977	$96,696	$100,564	$104,586	$108,770	$113,121	$117,646	$122,351	$127,245
Net cash flow (out)	$6,136,625	$89,401	$92,977	$96,696	$100,564	$104,586	$108,770	$113,121	$117,646	$122,351	$312,338
NPV = **$6,601,893**											
Alternative 3:											
Initial cost	$6,224,242										
Maintenance											$179,412
Ice Suppression Electricity		$114,944	$119,542	$124,324	$129,296	$134,468	$139,847	$145,441	$151,259	$157,309	$163,601
Net cash flow (out)	$6,224,242	$114,944	$119,542	$124,324	$129,296	$134,468	$139,847	$145,441	$151,259	$157,309	$343,013
NPV = **$6,764,401**											
Alternative 4:											
Initial cost	$8,150,406										
Maintenance		$35,533	$36,955	$38,433	$39,970	$41,569	$43,232	$44,961	$46,760	$48,630	$50,575
Ice Suppression Electricity		$89,401	$92,977	$96,696	$100,564	$104,586	$108,770	$113,121	$117,646	$122,351	$127,245
Net cash flow (out)	$8,150,406	$124,934	$129,932	$135,129	$140,534	$146,156	$152,002	$158,082	$164,405	$170,981	$177,821
NPV = **$8,544,243**											
Alternative 5:											
Initial cost	$7,590,217										
Maintenance		$35,533	$36,955	$38,433	$39,970	$41,569	$43,232	$44,961	$46,760	$48,630	$50,575
Ice Suppression Electricity		$89,401	$92,977	$96,696	$100,564	$104,586	$108,770	$113,121	$117,646	$122,351	$127,245
Net cash flow (out)	$7,590,217	$124,934	$129,932	$135,129	$140,534	$146,156	$152,002	$158,082	$164,405	$170,981	$177,821
NPV = **$7,984,054**											
Alternative 6:											
Initial cost	$7,700,406										
Maintenance		$35,533	$36,955	$38,433	$39,970	$41,569	$43,232	$44,961	$46,760	$48,630	$50,575
Ice Suppression Electricity		$89,401	$92,977	$96,696	$100,564	$104,586	$108,770	$113,121	$117,646	$122,351	$127,245
Net cash flow (out)	$7,700,406	$124,934	$129,932	$135,129	$140,534	$146,156	$152,002	$158,082	$164,405	$170,981	$177,821
NPV = **$8,094,243**											

8.0 OPERATION AND MAINTENANCE CONSIDERATIONS

Operation and maintenance considerations played a vital role in the development of alternatives for this study. The alternatives were developed so as to minimize the effort and costs involved with the routine operation and scheduled maintenance of the facility as well as maintenance and operation in emergency situations. The operation and maintenance issues and concerns for the alternative recommended in Section 7.2, pneumatically operated hinged-leaf gates with a conventional concrete ogee spillway and jet-grouting of the abandoned powerhouse substructure, are discussed in this section.

8.1 Reservoir Water Surface Elevation Control

A design parameter for the development of all alternatives was to provide a stable upstream pool water surface elevation of between 636.0 feet and 636.5 feet. The recommended alternative will accomplish this with an automated control system that would tie into the controls of the existing powerplant. The discharge-rating curve for this alternative is shown on Figure 8.1. A preliminary schematic of the control system, as provided by the gate manufacturer, is presented in Figure 8.2 (at the end of this section).

Figure 8.1 shows the stage-discharge rating curves for the recommended alternative as well as the current conditions, in addition to the site's tailwater-rating curve. As can be seen from the rating curves, the recommended alternative provides much greater flexibility and control of the upstream pool elevation, and can result in lower upstream water surface elevations (than the existing conditions), if desired.

An OWR concern regarding the operation of the concrete ogee was the formation of a roller at the toe of the ogee during certain discharge conditions. The ogee has been designed such that the probability of the formation of a roller has been eliminated. This was accomplished by providing a higher downstream apron and providing riprap downstream of the apron. Computations were then conducted that showed that a roller will not form under any Rock River flow conditions up to the

100-year flood if the spillway geometry and configuration are as shown on Figure Final 17".

8.2 Minimum Spill Requirements

Minimum spill requirements at the site includes spilling one-tenth of a foot of water over the existing crib dam's flashboards. After the reconstruction of the dam and gates this requirement will be met in two ways:

a. During the months of April through November, the upstream pool elevation will be maintained at 636.1 feet, and the minimum spill will be spilled over the new concrete ogee (reasons discussed in Section 8.3).

b. During the months of December through March, the upstream pool elevation will be maintained at 636.0 feet, and the required minimum spill will be spilled over the new pneumatically operated hinged-leaf gates.

8.3 Winter Operation of Gates

Satisfactory and reliable operation of the gates during winter ice conditions was a critical design consideration. Hinged-leaf gates are the best available gates for use in such harsh and extreme cold environments.

In order to prevent ice from forming and bonding to the upstream face of the gate's skin plates, water will be continuously spilled over them during the months of December through March. This mode of operation allows the natural transport of heat, contained in water with a temperature above 32° F, to keep the gates ice-free. In addition, gate abutment and pier heaters are being provided to keep the gate side seals free of ice so that the gates can easily be lowered and raised when required.

Studies associated with this feasibility study determined that frazil ice, while produced at most of the dams along the Rock River, is not a significant problem.

Frazil ice problems will only occur when severely low temperatures occur in combination with certain hydrologic and hydraulic conditions, including open water over long reaches. Once the normal reservoir and river ice sheets form, frazil ice production is stopped by the insulating action of the ice sheets. Production continues only in the areas adjacent to dam spillways where open water remains. Operation of the proposed Sinnissippi Dam facilities will not significantly change the normal ice flow regime.

Spring ice break-up conditions at Sinnissippi Dam can vary greatly from year to year. Under low river discharge conditions, the ice sheet may melt in place and under sudden melting and flood conditions, as were experienced in 1994, a relatively thick ice sheet (6-9 inches) may break-up. The 1993-1994 winter weather was one of the severest on record, and produced an ice sheet which varied in thickness from a measured minimum of 10 inches to a maximum of 18 inches at different locations. The average thickness was approximately 14 inches.

The proposed gates have the ability of passing a breaking ice sheet without incident. This can be accomplished without passing a greater rate or quantity of ice than would be passed by the existing radial gates. In addition, the 1994 winter revealed that virtually all ice passed downstream is passed by the existing gates and not the overflow section, and therefore, the lateral distribution of ice in the river downstream of the Dam will not be altered by the proposed gates.

8.4 Sediment Transport

The proposed alternative will not significantly alter the existing sediment transport regime. The gate sills of the recommended alternative are at elevation 626.5 feet which is only slightly below elevation 626.7 of the existing gates. In addition, the shorter length gates (48 feet long) are being provided so that they can be completed opened to pass sediment during periods of low river flow.

Studies performed on the Rock River and referenced by this feasibility study have

concluded that the Rock River Basin produces very little sediment which is transported as bedload. At Sinnissippi Dam, the average annual bedload transport volume is approximately 1% of the average annual suspended sediment transport volume, which are 13,000 tons/year and 1,350,000 tons/year, respectively. The proposed spillway gates will not significantly alter the sediment transport regime.

8.5 Control of Water During Gate Maintenance

Several alternatives were evaluated for dewatering individual bays during gate maintenance. A description of the two most feasible alternatives follows:

a. Full-span crane-placed bulkheads would provide effective control of water during gate maintenance operations. However, these bulkheads would either need to be placed from a barge-mounted crane or they would have to be placed from the access bridge for the new gates. A barge-mounted crane would not be desirable because either the OWR will have to purchase it and permanently store it at the site or they would have to rent it and transport it to the site which may not be always feasible during emergencies. Cranes located on the access bridges are not desirable because the bridges would then need to be designed for much higher loads that would make them prohibitively expensive.

b. The preferred and recommended alternative is to provide floating bulkhead stoplogs which would be stacked to form a full-height bulkhead. The proposed system would consist of floating steel bulkheads that would span the entire shorter-width (48 feet long) bays without any intermediate supports. Bulkheading the longer-width (96 feet long) bays would require two sections similar to the 48 feet bay ones with a soldier pile in the middle providing the required support. The individual bulkhead stoplogs would consist of rectangular structural steel tubing with steel angles welded to the bottom at the upstream and downstream ends (please see Figure Final 21" for a typical cross-section of an individual bulkhead element). Valves would be provided

to selectively introduce water inside the bulkheads so that they can be submerged (or sunk). Seals will be provided at the bottom of each bulkhead element along its entire length and at the face bearing against the bulkhead slot. After a complete bulkhead is installed upstream of the gate, the water level in the area between the bulkhead and the gate will be lowered to the level of the tailwater by lowering the gate. After the complete downstream bulkhead is installed, the whole bay would be dewatered by pumping-out the remaining water. During this time the outside water pressure would help to seal the surfaces along the bulkhead slots in the piers and, if applicable, the soldier pile. After the necessary maintenance/repair work on the gates is performed and there is no need for the bulkheads, water (that was originally used for submerging) would be drained out of each individual bulkhead element. Next, water would be introduced into the dewatered area through conduits incorporated in the individual bulkhead stoplogs to fill that area up and make the bulkheads float from the slot using their natural buoyancy.

The individual bulkhead stoplogs would be permanently stored on top of two special-geometry piers that would be at the ends of a short-width (48 feet wide) bay. Separate fixed hoists will be provided on each of the two piers that would be used to lower the bulkhead stoplogs into the water or raise them out of it for storage. The individual bulkhead stoplogs will be transported from one bay to the other by floating them in the water with a cable/eye/winch setup. To guide them close to the upstream (and downstream) ends of the piers, the cable will be passed through steel eyes attached to the upstream (and downstream) noses of the piers, high enough to avoid being damaged from ice.

8.6 Other Operational Issues and Concerns

Several other operational issues were evaluated for all the final alternatives considered. Those relating to the recommended alternative are discussed below:

8.6.1 Leaks in the (pneumatic) air lines

To prevent leaks in the air piping, stainless steel pipes will be used. Expansion couplings would be used at concrete joints to ensure that any expansion and contraction of concrete does not cause excessive strain in the piping. In addition, separate inflation and deflation lines will be used for each section of gate (i.e. for each bay) along with check valves to tee the lines together at each air bladder. This system will isolate each air bladder, which means that if one air bladder is damaged and starts leaking, the other air bladders will not deflate by discharging air through the damaged air bladder. It will also guard against unintended deflation caused by damage/leakage in an inflation air pipe. Alternatively, separate inflation and deflation pipes may be used for each individual air bladder for a minimal (approximately $15,000) increase in the cost of the gates.

The probability of leakage in air supply pipes can be minimized by closely scrutinizing the pipes for leaks before embedding them in concrete. The probability of leaks occurring in the pipes during the project life is further minimized by the use of a desiccant-style (compressed) air dryer that ensures that the compressed air used to actuate the gate system is dry to a dew point of -40° F. In addition, the use of a condensate purge valve, which is used to periodically drain any water that accumulates in the piping system, would further decrease the probability of ice forming and damaging the pipes. To date, the manufacturer of the gates has not experienced any incidents of leaks in the air supply pipes of gates that have already been installed and are currently in operation.

8.6.2 Electrical Power Outages and Compressor Failure

An electrical power outage will not negatively impact the operation of gates. The gates are actuated as required when an upstream bubbler system detects a different water surface elevation than that given in the rule curve. When a

power failure occurs, the system would be able to keep the gates at the same level or, if required, would lower them by deflating the air bladders. However, since the compressors would not be able to operate, the bladders would not be re-inflated until the power comes back on. The bubbler uses approximately 1-2 ft^3/hour of air which in combination with the compressed air accumulator would allow the gates to function for more than a month without power. In addition, auxiliary air line connections will be provided to hook-up portable generators and compressors in emergencies.

The impact of compressor failure will be similar to that of an electrical power outage. A multiple compressor air supply system will be used for system redundancy so that if one compressor fails or needs to be serviced, the other compressor would adequately serve the requirements of the gate system. However, if both compressors fail at the same time the bladders will still remain inflated, and deflate only if required. The ability to connect an auxiliary emergency air compressor will also be provided in addition to the ability to bypass the air dryer in case of multiple compressor failure.

8.6.3 Slow Leaks in an Air Bladder

Small and slow leaks, such as bullet holes, in the air bladders will need to be fixed by a tubeless tire patch kit while the bladders are inflated. The compressor system is designed such that it can keep up with a large number of bullet holes in the bladders and does not let the bladders deflate (due to the bullet holes). Leaks and bullet holes will be detected by an adjustable flow switch incorporated in the control system that would send an alarm signal if the gate system is using more air than normal.

In order to fix the leaks or bullet holes, a repair-person will have to climb down from the piers and walk to the affected bladder on the downstream side of the gates. This repair work may be done without dewatering the bay downstream of the gates. If the bay is not dewatered, the repair-person will

have to walk or stand in tailwater more than two feet deep. In addition, the upstream pool water surface elevation will have to be lowered from the normal 636.0 feet so that water does not splash over the gates due to wave action, etc.

The probability of slow leaks occurring in situations other than sabotage is minimal. The gate manufacturer cites only one instance of a slow leak in an air bladder in which an earlier model, non-Kevlar reinforced, air bladder was punctured with an ice pick. The recommended system will have the Kevlar reinforced air bladders that the manufacturer claims are highly resistant to punctures, even those caused by bullets.

8.6.4 Catastrophic Failure and Complete Deflation of an Air Bladder

Catastrophic failure and complete deflation of an air bladder will cause a 16-foot wide section of the gate to fully open. However, the adjacent gate panels will not be affected. The maximum discharge through (failed) open gate area, with the upstream pool at elevation 636.0 feet, will be approximately 1,650 cfs.

The entire air bladder will need to be replaced. In order to replace the failed bladder, the entire bay will have to be dewatered by placing the upstream and downstream floating bulkheads. The operation to place the bulkheads and dewater could take at least one whole 10-hour day. Replacing the bladder will take an additional 10-hour day, and re-watering and removing the bulkheads may take an additional day. To replace the bladder, a light mobile (truck-mounted) crane located on the access bridge will have to lift the gate to a vertical (or closed) position to remove the old bladder and install the new one. However, it should be noted that if conditions do not permit the installation of the floating bulkheads, a temporary earthfill cofferdam will have to be built in order to perform the repairs in the dry. The gate manufacturer claims that there has never been a catastrophic failure of an air bladder.

FIGURE 8.1

SINNISSIPPI DAM
Discharge-Rating Curve

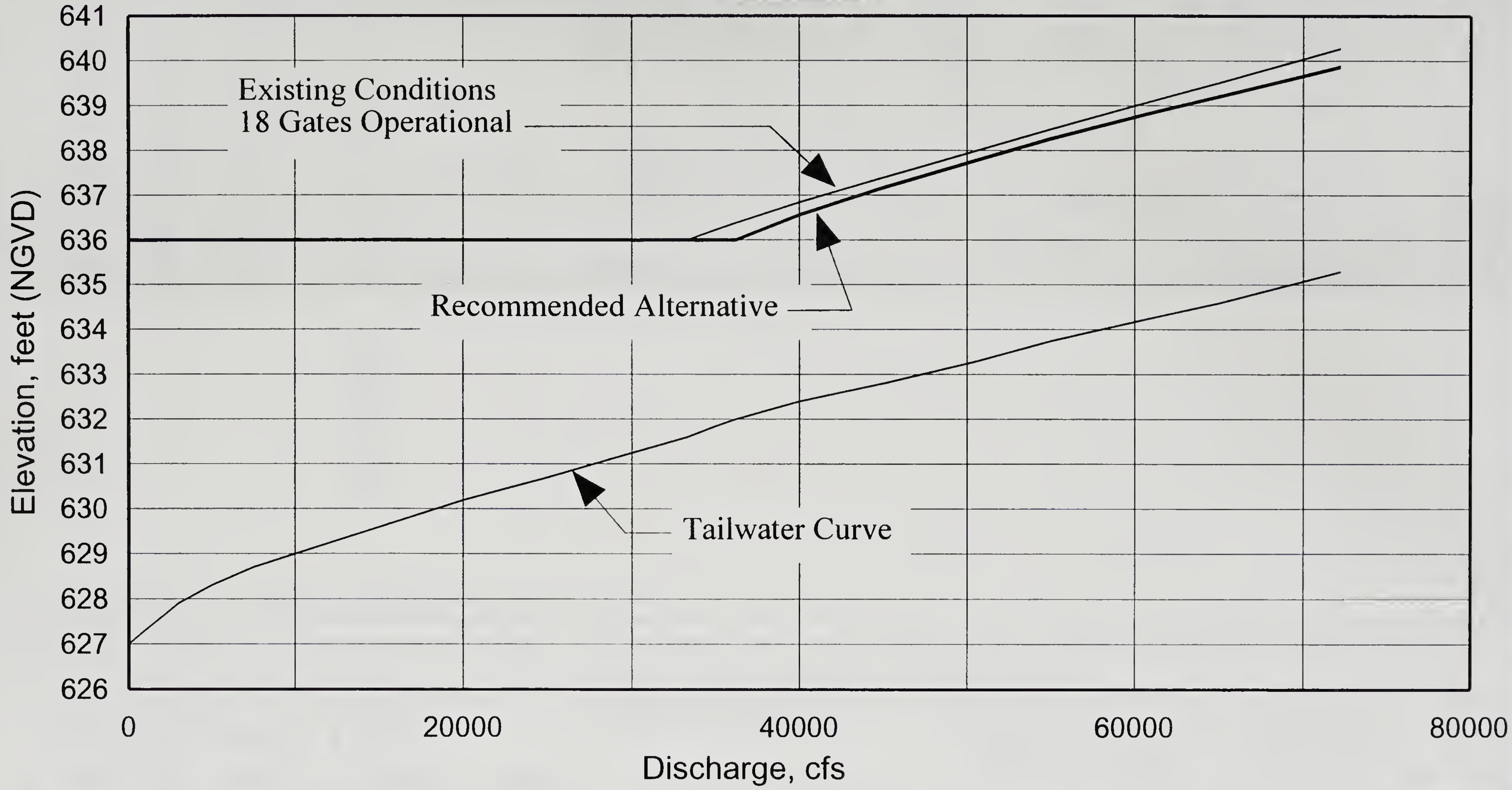
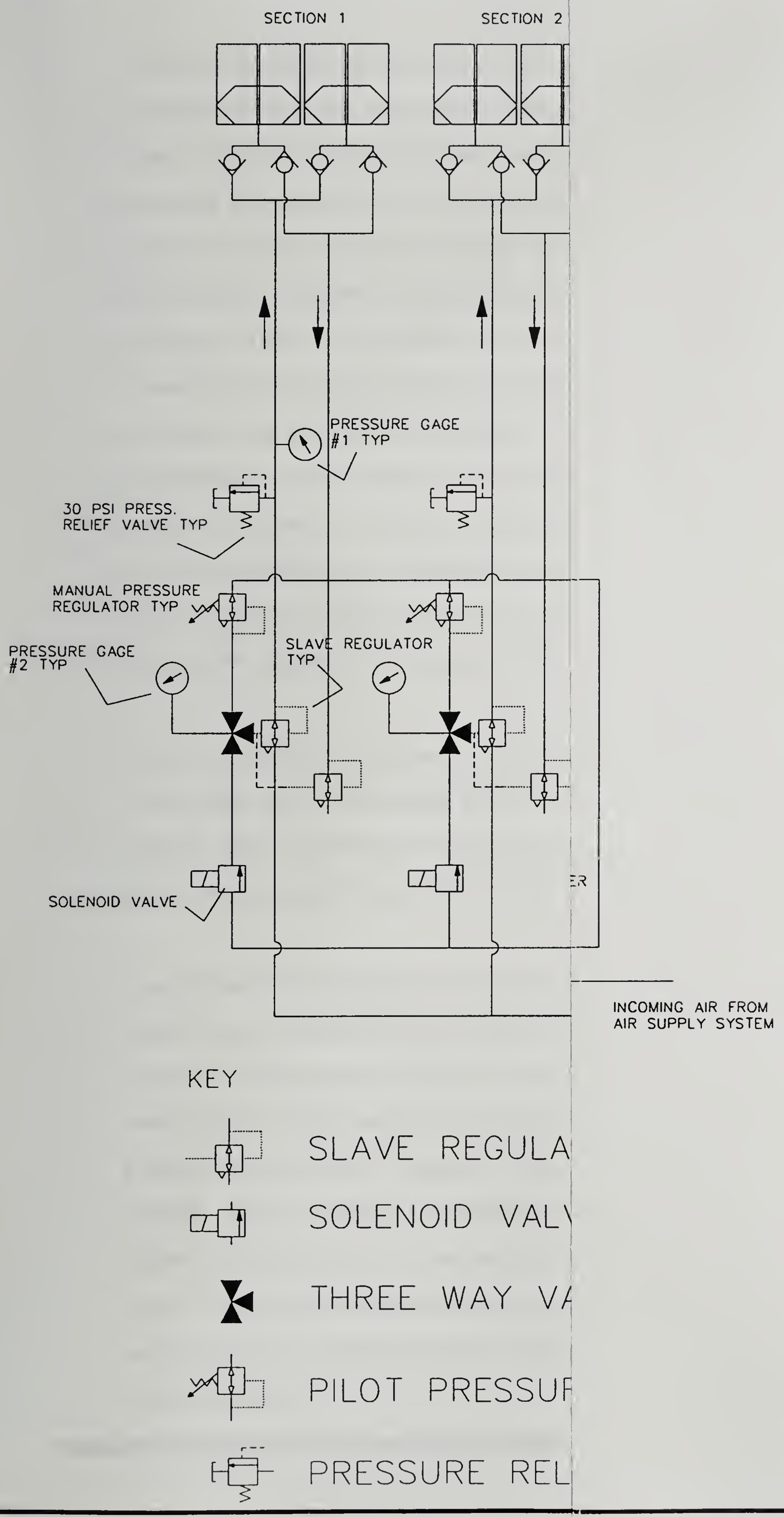


FIGURE 8.2



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NO	REVISION	DATE	DRAWN
1	APPROVAL	11/21/95	THAD

DRAWING DESCRIPTION

CONTROL SCHEMATICS

OBERMEYER
HYDRO ACCESSORIES, INC

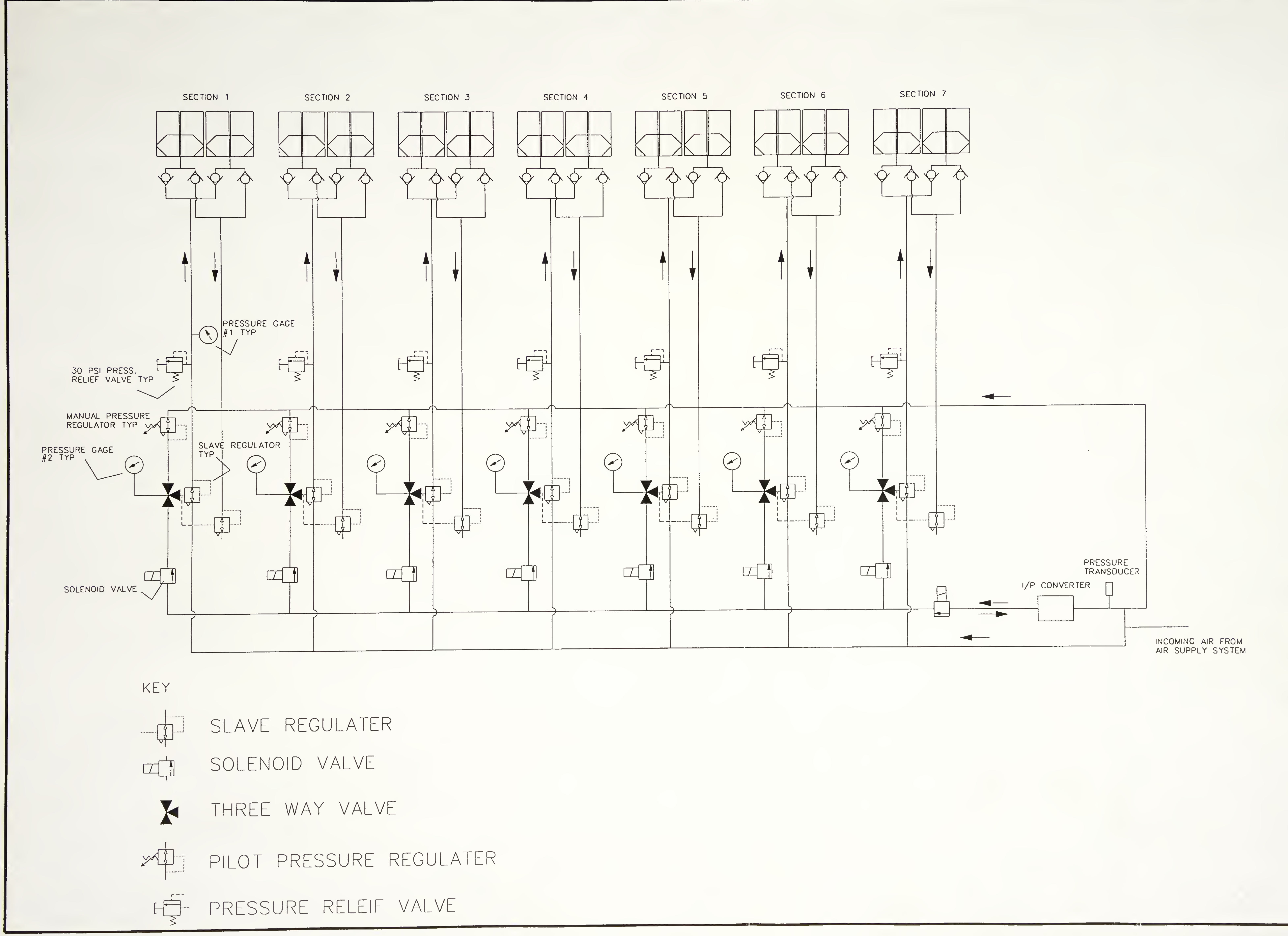
P.O. BOX 668
FORT COLLINS, COLORADO 80522
TEL 970-568-9844 FAX 970-568-9845

SCALE
NONE

JOB
ROCK RIVER DAM

DWG. NO.
SD95400

FIGURE 8.2



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ROCK RIVER DAM

DWG. NO.
SD95400

9.0 CONCLUSIONS AND RECOMMENDATIONS

After evaluating all the alternatives, it is concluded that Final Alternative 2, "Pneumatically Operated Hinged-leaf Gates with Conventional Concrete Spillway Replacing the Existing Gates, Flashboards and Crib Dam, and Jet Grouting of the Right Bank Powerhouse Ruins", provides the best solution for the reconstruction of Sinnissippi Dam. This alternative involves the installation and construction of three 48-foot long and four 96-foot long pneumatically operated hinged-leaf gates, and a 504-foot long conventional concrete ogee spillway. The new structures will be constructed downstream of the existing crib dam. Construction of the new structures will require demolition and removal of the existing gates and piers, and a 76 feet long section of the existing crib dam. The right bank abandoned powerhouse's substructure will remain intact, however, a jet-grouted cut-off wall will be installed to provide a positive seepage cut-off. A detailed description is given in Section 6.2.2 and the figures are included in Section 12. The total cost of construction is estimated to be $6,136,625 and the present value of the construction cost and O&M costs for the first 60 years of operation is estimated to be $6,601,893 (please see Section 7.2).

The recommended alternative adequately satisfies the performance criteria set for the redevelopment of Sinnissippi Dam. It is the least cost alternative evaluated and will not conflict with or negatively impact the Sterling Park District's plans for the development of a park on the right bank of Rock River.

A schedule for the implementation of the project is presented in Figure 9.1. It may be noted in the schedule that the Phase-II installation of the access bridge, demolition and removal of the existing gates and piers, and the removal of the downstream cofferdam would occur in the months of February and March. These activities are not crucial for passing floods of high magnitude since the new gates will be operational by the end of January. In case, there is a flood that requires opening of the new gates constructed during Phase-II, the gates can be lowered and the Phase-II downstream cofferdam allowed to wash away. The access bridge construction and the demolition and removal of the existing gates and piers are not schedule-critical items and can be completed any time after the installation of the new gates.

It is recommended that the project specifications and bid documents be prepared for Final Alternatives 2 and 5. Final Alternative 5 is quite similar to Final Alternative 2 in concept except that it uses hydraulic cylinder operated hinged-leaf gates as opposed to pneumatically operated hinged-leaf gates. Bids should be accepted for both alternatives and the lowest bidder should then be awarded the contract. The advantage of accepting bids for both alternatives is that there currently is only one manufacturer/supplier of the pneumatically operated gates, and getting alternative bids would introduce competition that could result in lower overall bid prices. The additional cost of preparing two sets of contract documents would be approximately $75,000. This cost is not significant relative to the savings that could be achieved by competitive bidding.

FEASIBILITY STUDY FOR THE REHABILITATION OR RECONSTRUCTION OF SINNISSIPPI DAM

RECOMMENDED ALTERNATIVE IMPLEMENTATION SCHEDULE

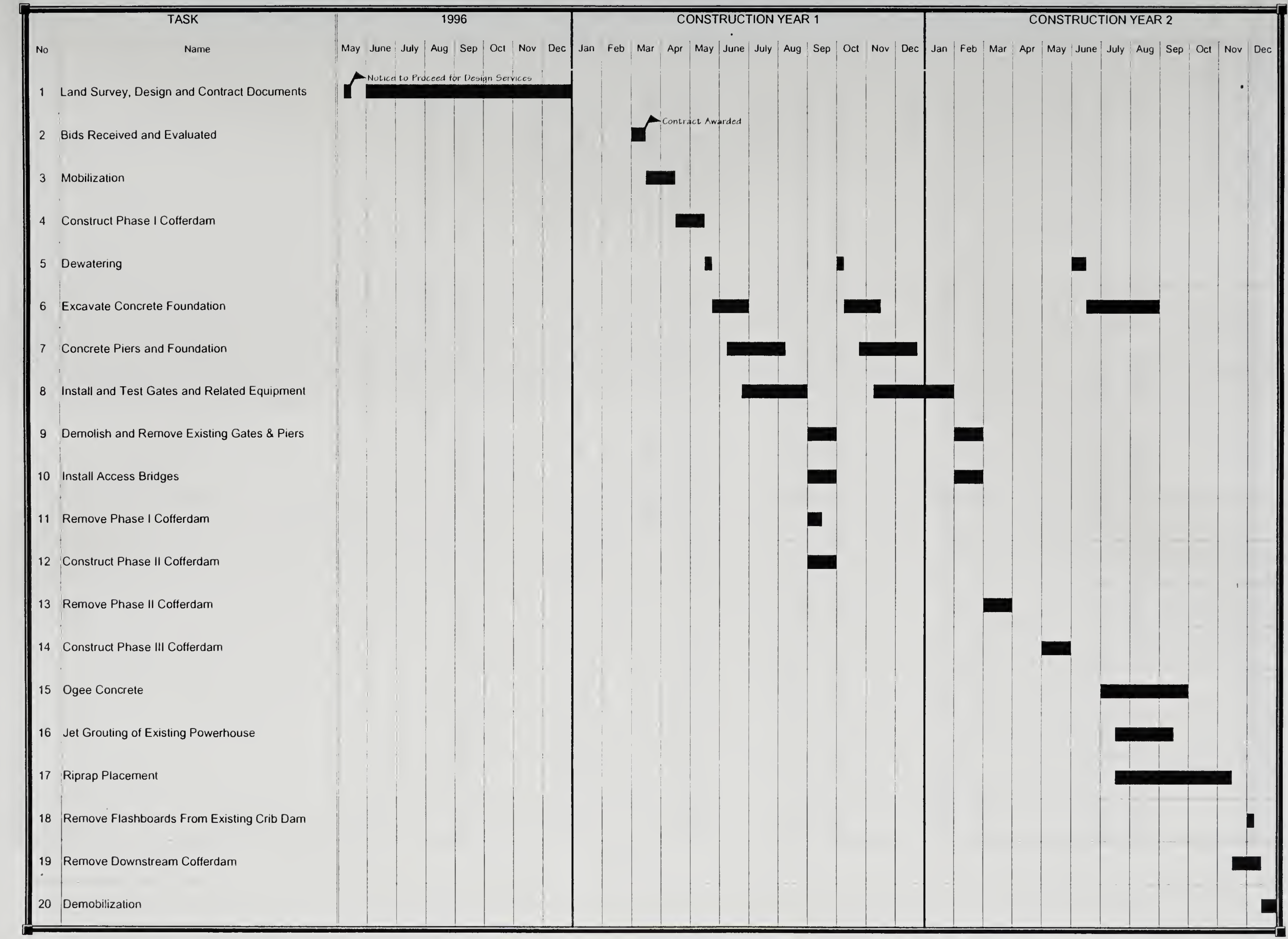


FIGURE 9.1

10.0 REFERENCES

1. US Geological Survey, Water Resources Investigations Report 83-4136; "Measurement of Bedload Discharge in Nine Illinois Streams with the Helley-Smith Sampler"; 1983.

2. Bhowmik, N., Adams, J. R., Bonini, A., Klock, A. and Demissie, M.; "Sediment Loads of Illinois Streams and Rivers"; Illinois State Water Survey, Champaign, 1986.

3. Engineers International, Inc.; "Subsurface Exploration for the Rock Falls Hydroelectric Project", Final Report prepared for Stanley Consultants, Inc.; May 1986.

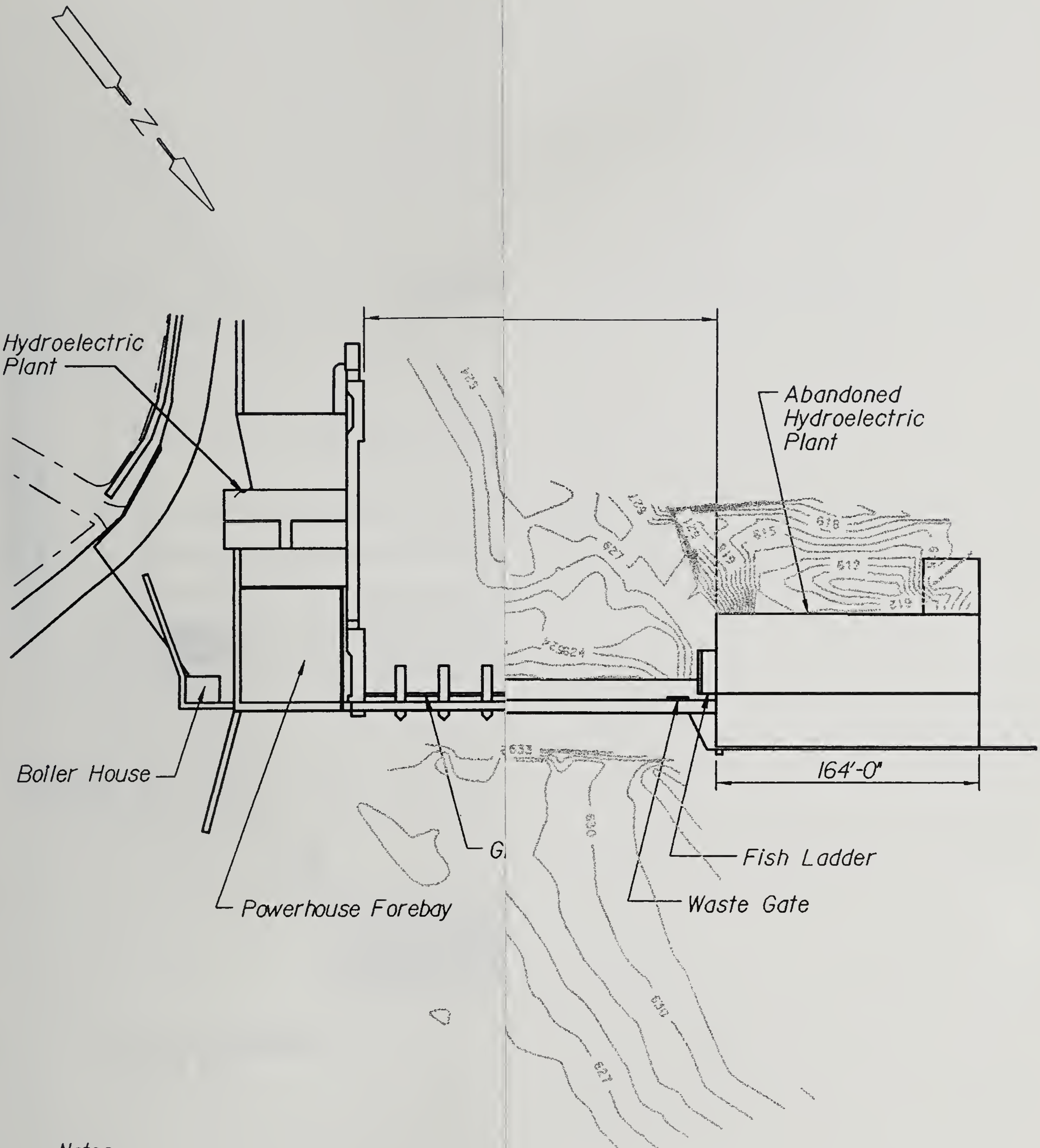
4. US Army Corps of Engineers, Rock Island District; "Sinnissippi Dam Major Rehabilitation Feasibility Report"; August 1988.

5. Woodward-Clyde Consultants, "Feasibility Study Report for the Sinnissippi Dam", February 21, 1991.

6. Woodward-Clyde Consultants, "Addendum to the Feasibility Study Report for the Sinnissippi Dam", January 29, 1992.

SECTION 11

FIGURES,
PRELIMINARY ALTERNATIVES



Notes:

1. *Survey information and dimensions of existing structures obtained from U.S. Army Corps of Engineers, "Sinnissip Dam Major Rehabilitation Feasibility Report", August, 1988.*

2. *River bottom contours developed from hydrographic survey conducted by Collins Engineers, Inc. in July, 1994 and June, 1995.*

RS, INC.

ST.

0606

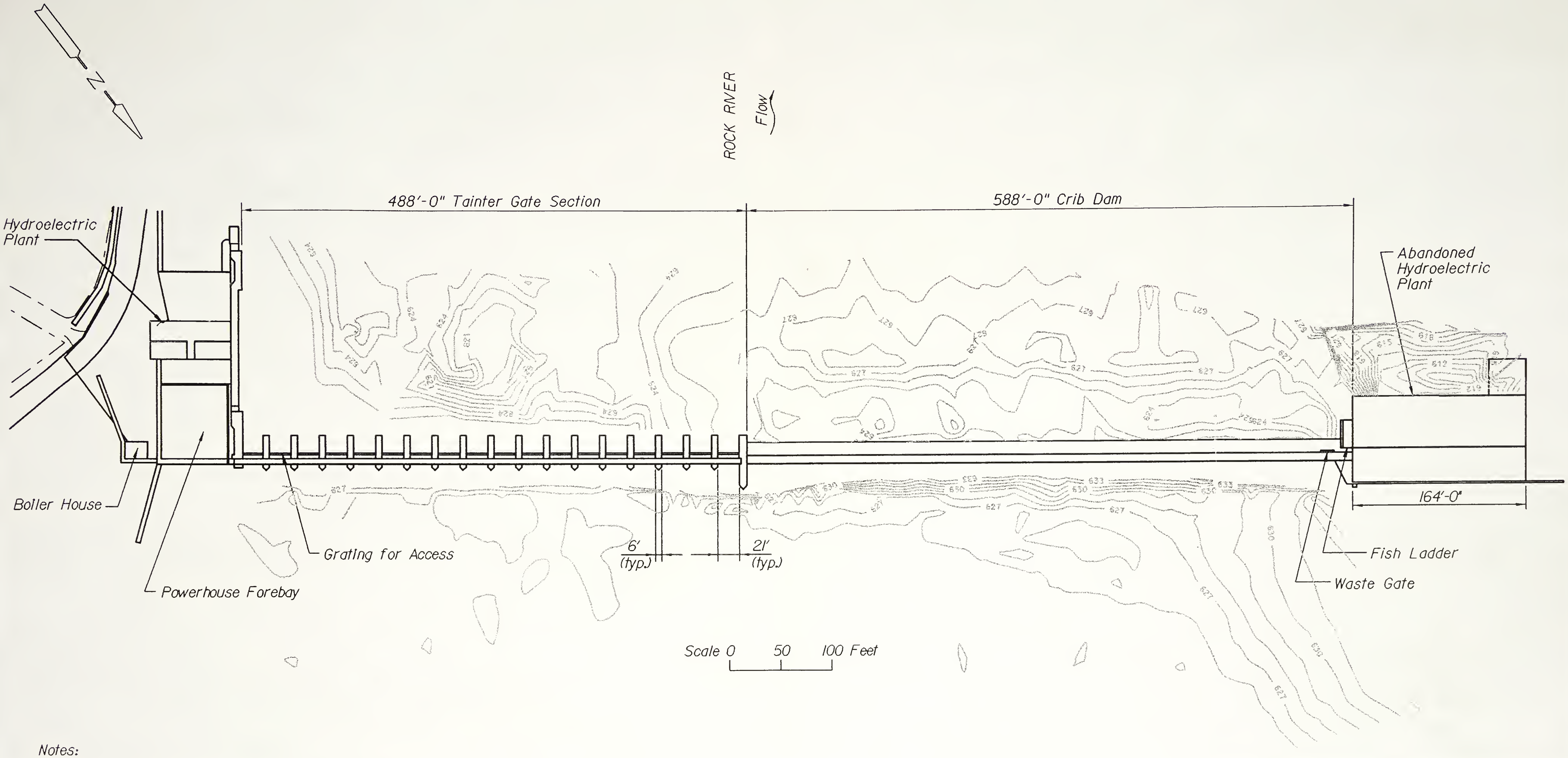
ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

EXISTING CONDITIONS

PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Prelim. 1



Notes:

1. Survey information and dimensions of existing structures obtained from U.S. Army Corps of Engineers, "Sinnissippi Dam Major Rehabilitation Feasiblity Report", August, 1988.
2. River bottom contours developed from hydrographic survey conducted by Collins Engineers, Inc. in July, 1994 and June, 1995.

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

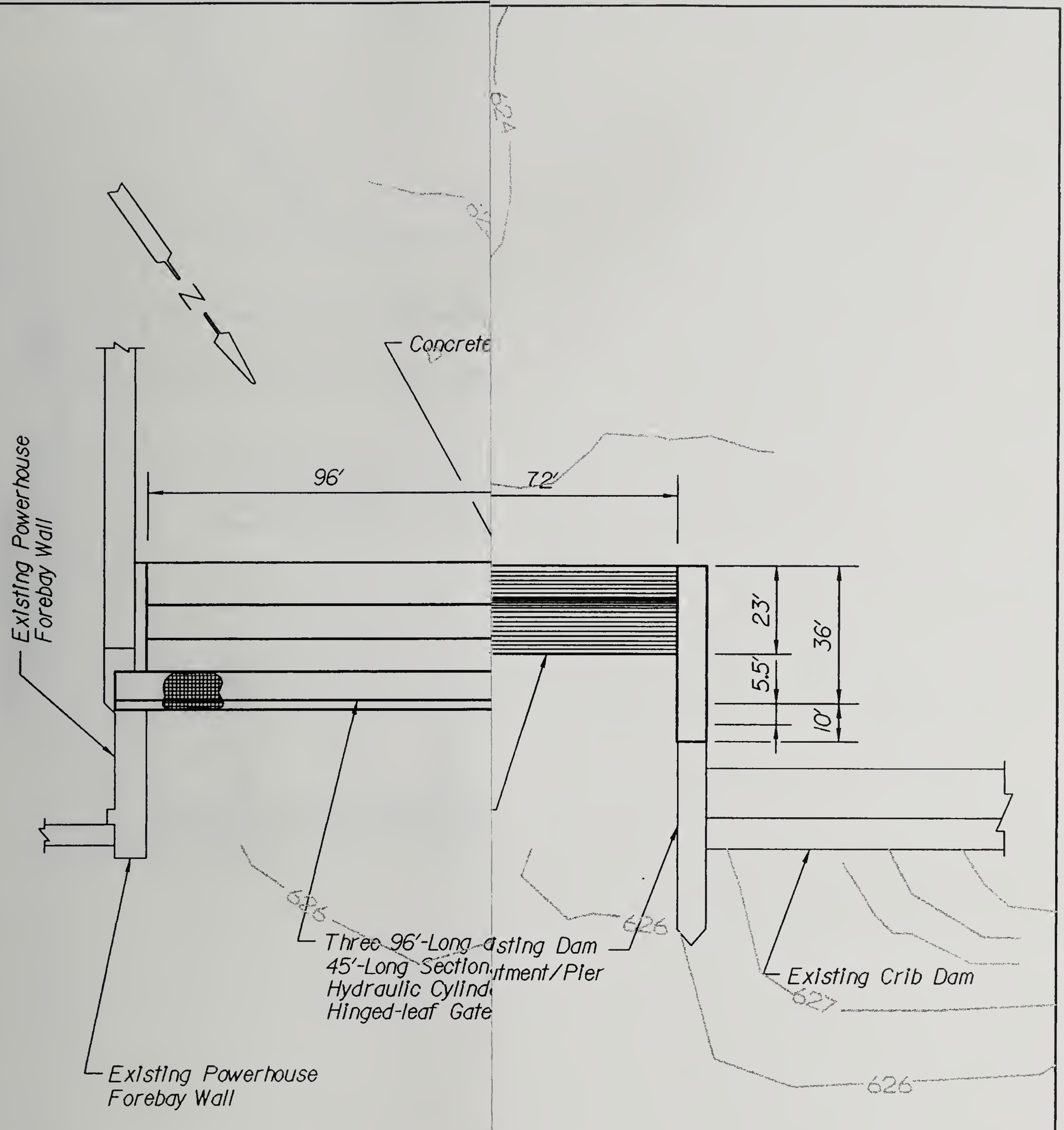
EXISTING CONDITIONS

PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Prelim. 1

G:1731-17310001



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ILLINOIS
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SINNISIPPI DAM
REPLACEMENT

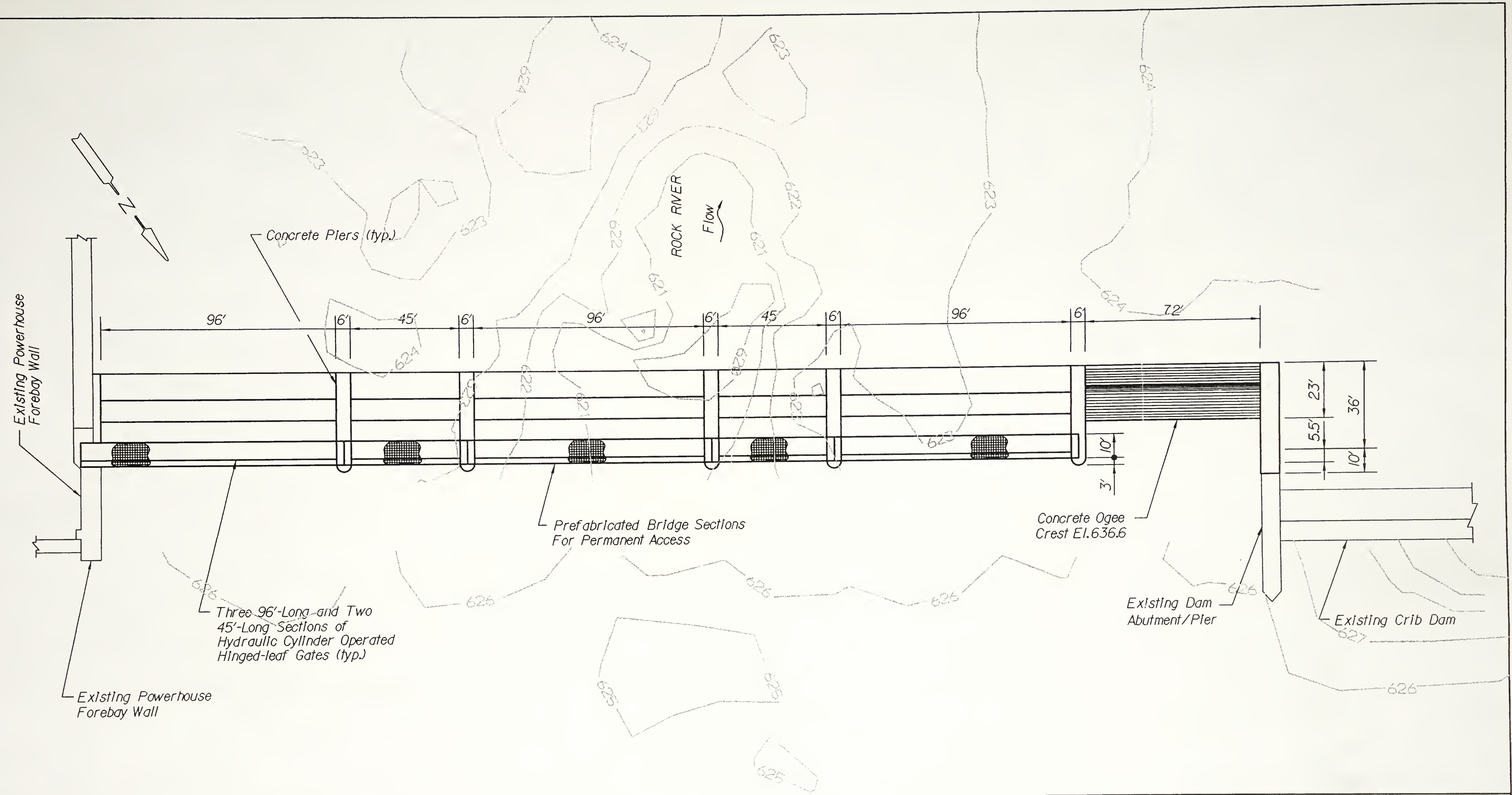
ALTERNATIVE 1:
HYDRAULIC CYLINDER
OPERATED HINGED-LEAF GATES
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 2

07/13/94 PRH

1731004A


N
Existing Powerhouse Forebay Wall
Concrete Piers (typ.)
ROCK RIVER
Flow
96'
6'
45'
6'
96'
6'
45'
6'
96'
6'
72'
23'
36'
5.5'
10'
10'
3'
Prefabricated Bridge Sections For Permanent Access
Concrete Ogee Crest El.636.6
Three 96'-Long and Two 45'-Long Sections of Hydraulic Cylinder Operated Hinged-leaf Gates (typ.)
Existing Powerhouse Forebay Wall
Existing Dam Abutment/Pier
Existing Crib Dam
621
622
623
624
625
626
627

PLAN

Scale 0 20 40 Feet

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ILLINOIS
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SINNISIPPI DAM
REPLACEMENT

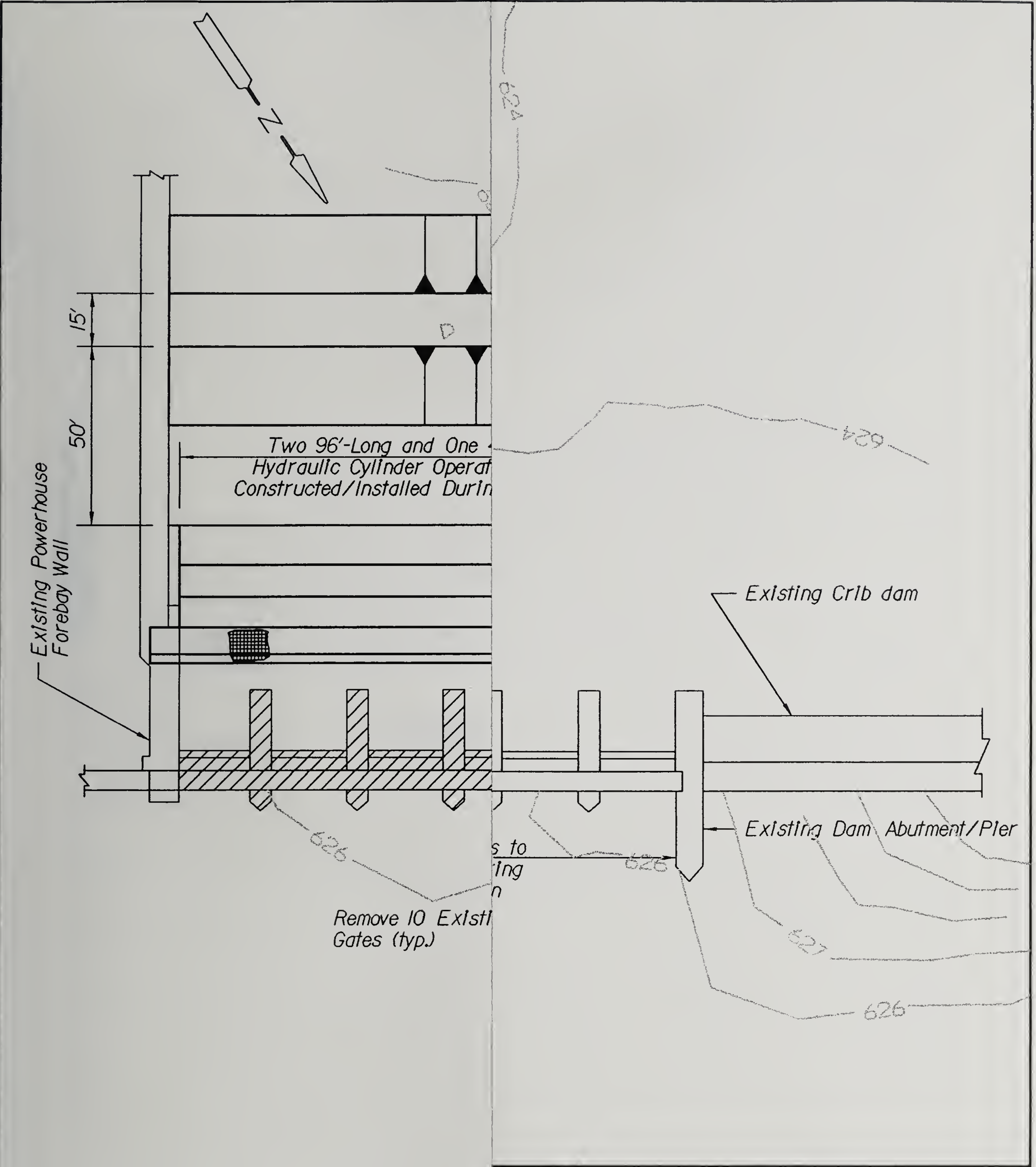
ALTERNATIVE 1:
HYDRAULIC CYLINDER
OPERATED HINGED-LEAF GATES
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 2

07/13/94 PRH

173:004A



ERS, INC.

L ST.

60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

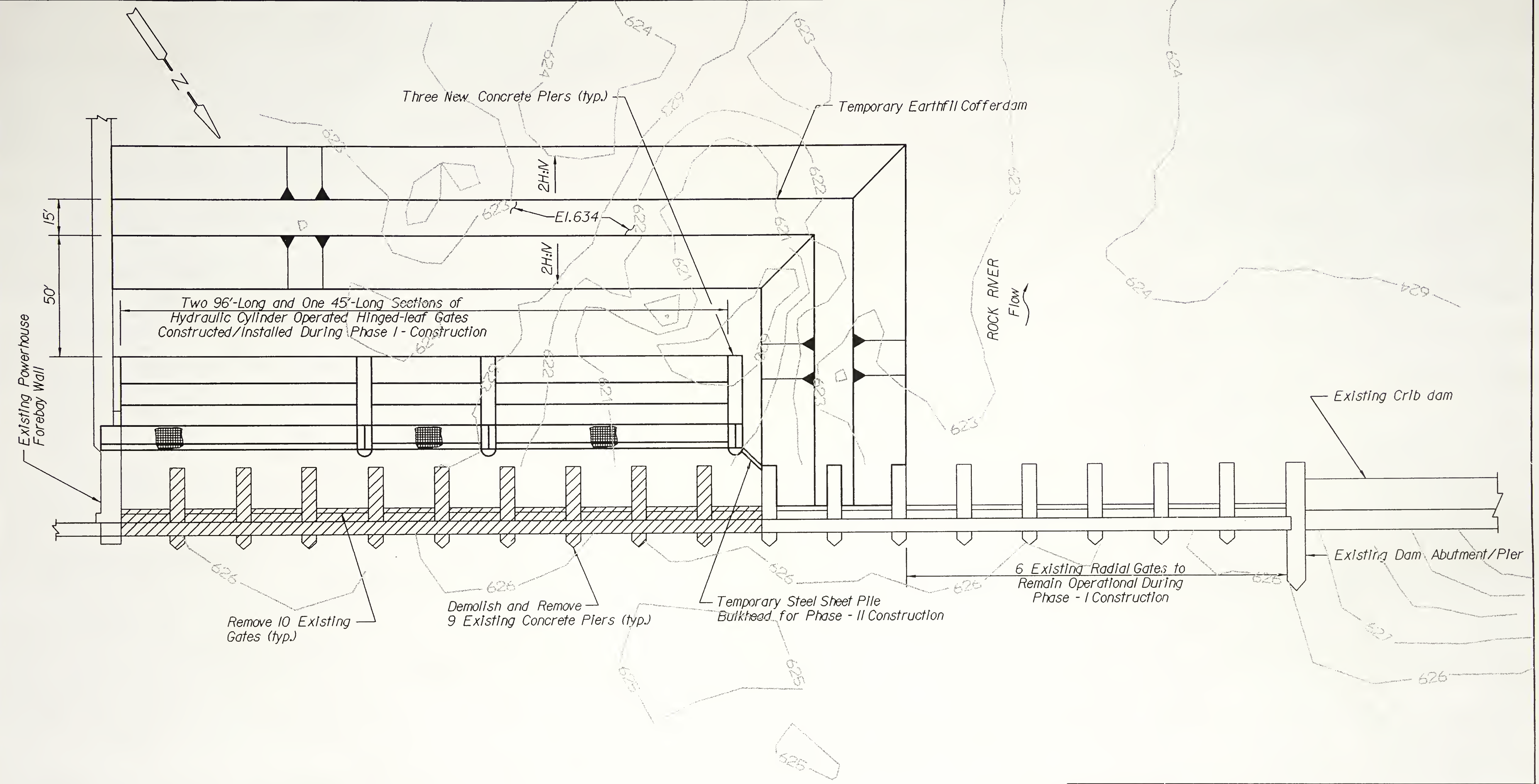
ALTERNATIVE 1:
HYDRAULIC CYLINDER
OPERATED HINGED-LEAF GATES
PHASE - I CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 3

07/13/94 PRH

1731016A


N
Three New Concrete Piers (typ.)
Temporary Earthfll Cofferdam
2H:1V
El.634
2H:1V
15'
50'
Two 96'-Long and One 45'-Long Sections of Hydraulic Cylinder Operated Hinged-leaf Gates Constructed/Installed During Phase I - Construction
Existing Powerhouse Forebay Wall
ROCK RIVER
Flow
Existing Crib dam
Existing Dam Abutment/Pier
6 Existing Radial Gates to Remain Operational During Phase - I Construction
Temporary Steel Sheet Pile Bulkhead for Phase - II Construction
Demolish and Remove 9 Existing Concrete Piers (typ.)
Remove 10 Existing Gates (typ.)
621
622
623
624
625
626
627

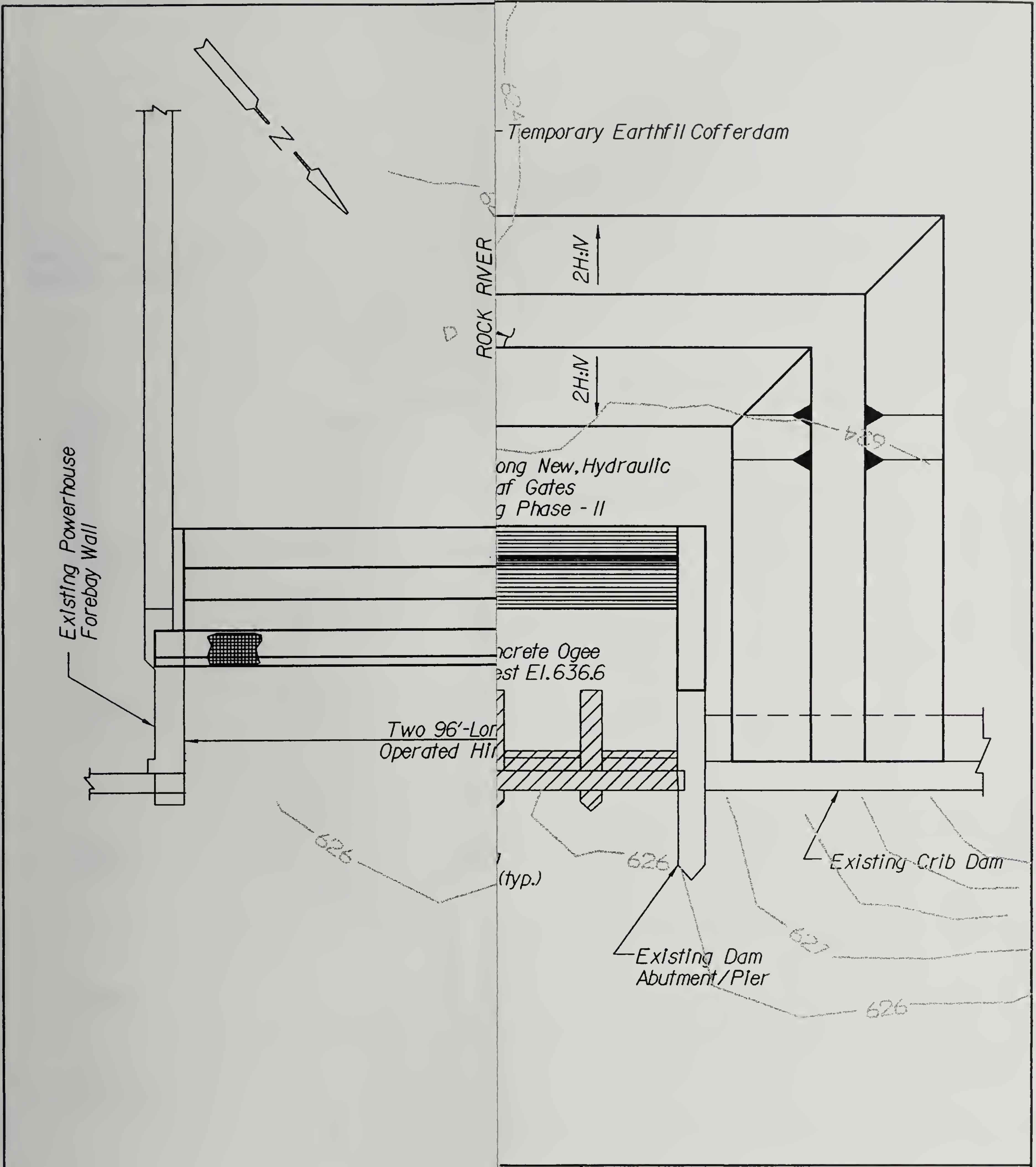
PLAN

Scale 0 20 40 Feet

COLLINS ENGINEERS, INC. 165 N. CANAL ST. CHICAGO, IL. 60606	ILLINOIS DEPARTMENT OF NATURAL RESOURCES SINNISIPPI DAM REPLACEMENT
	ALTERNATIVE 1: HYDRAULIC CYLINDER OPERATED HINGED-LEAF GATES PHASE – I CONSTRUCTION PLAN
	DRAWN BY: PRH CHECKED BY: QF
	DATE: AUGUST, 1994 FIG. Prelim. 3

07/13/94 PRH

1731016A



ERS, INC.

L ST.

60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

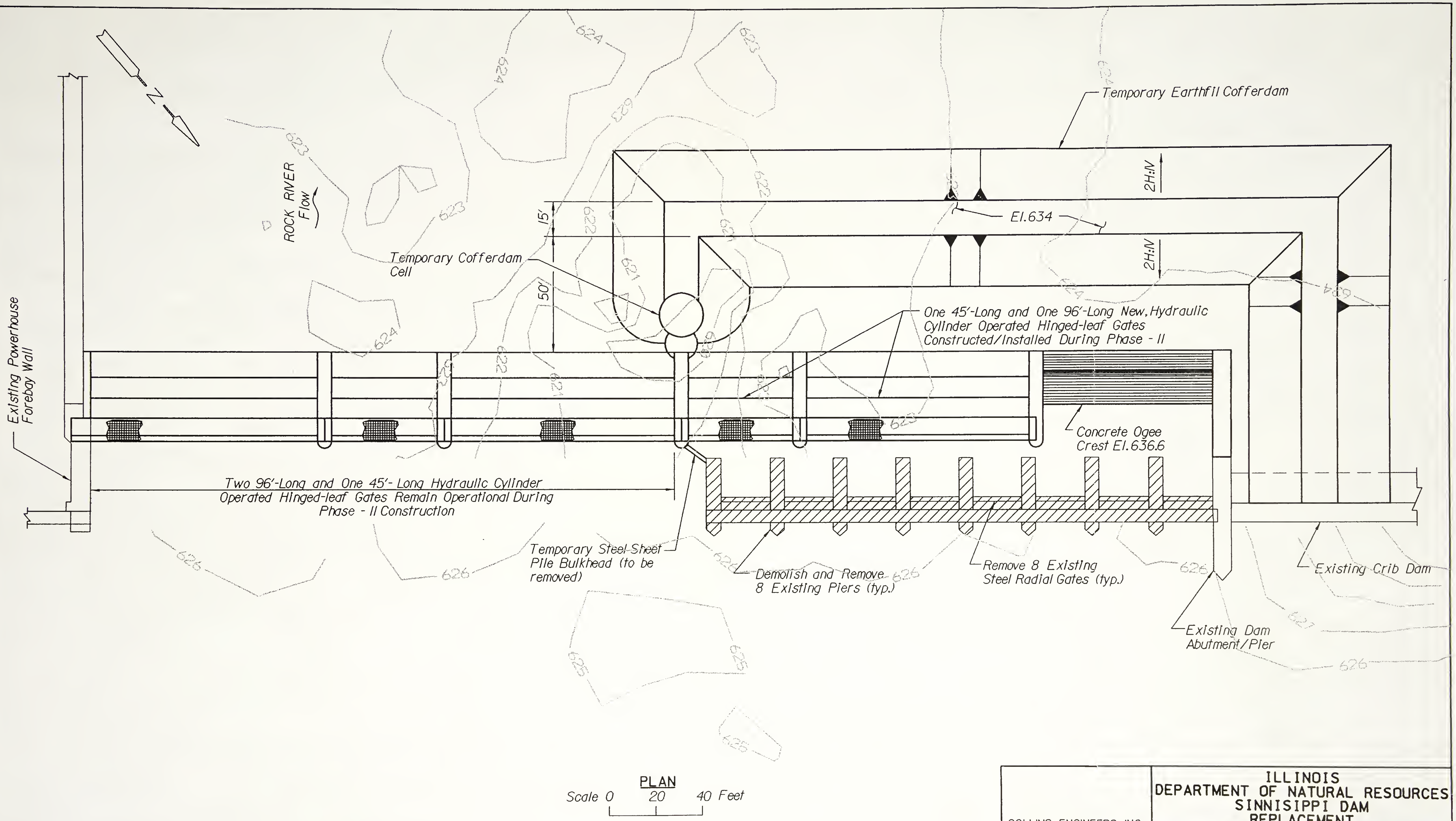
ALTERNATIVE 1:
HYDRAULIC CYLINDER
OPERATED HINGED-LEAF GATES
PHASE – II CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 4

07/13/94 PRH

1731017A


N
ROCK RIVER Flow
Existing Powerhouse Forebay Wall
Temporary Cofferdam Cell
15'
50'
Temporary Earthfil Cofferdam
2H:1V
El.634
2H:1V
One 45'-Long and One 96'-Long New, Hydraulic Cylinder Operated Hinged-leaf Gates Constructed/Installed During Phase - II
Concrete Ogee Crest El.636.6
Two 96'-Long and One 45'- Long Hydraulic Cylinder Operated Hinged-leaf Gates Remain Operational During Phase - II Construction
Temporary Steel-Sheet Pile Bulkhead (to be removed)
Demolish and Remove 8 Existing Piers (typ.)
Remove 8 Existing Steel Radial Gates (typ.)
Existing Crib Dam
Existing Dam Abutment/Pier
624
623
622
621
620
625
626
627
PLAN
Scale 0 20 40 Feet

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

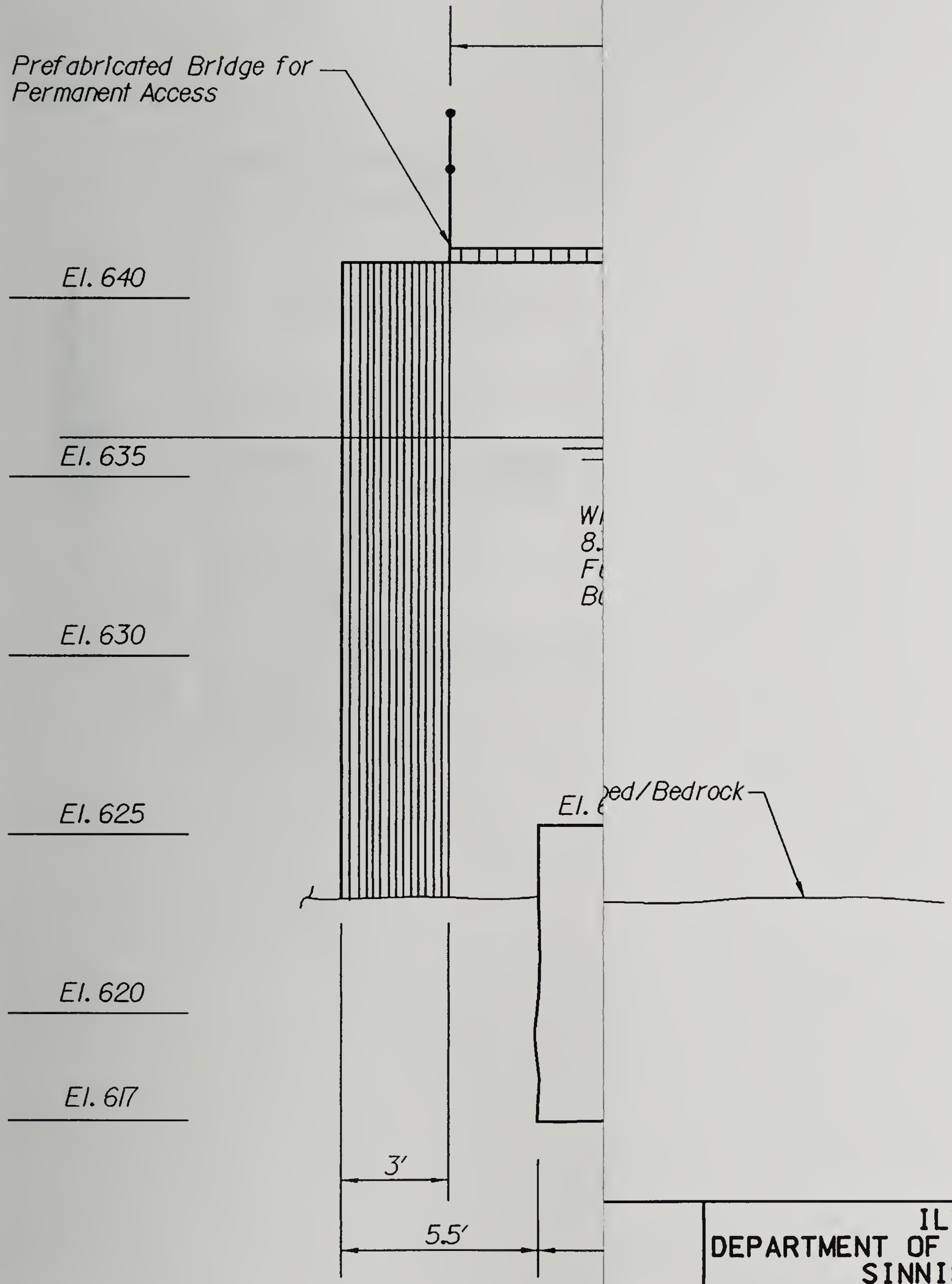
ALTERNATIVE 1:
HYDRAULIC CYLINDER
OPERATED HINGED-LEAF GATES
PHASE - II CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 4

07/13/94 PRH

1731017A



ERS, INC.

ST.

0606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

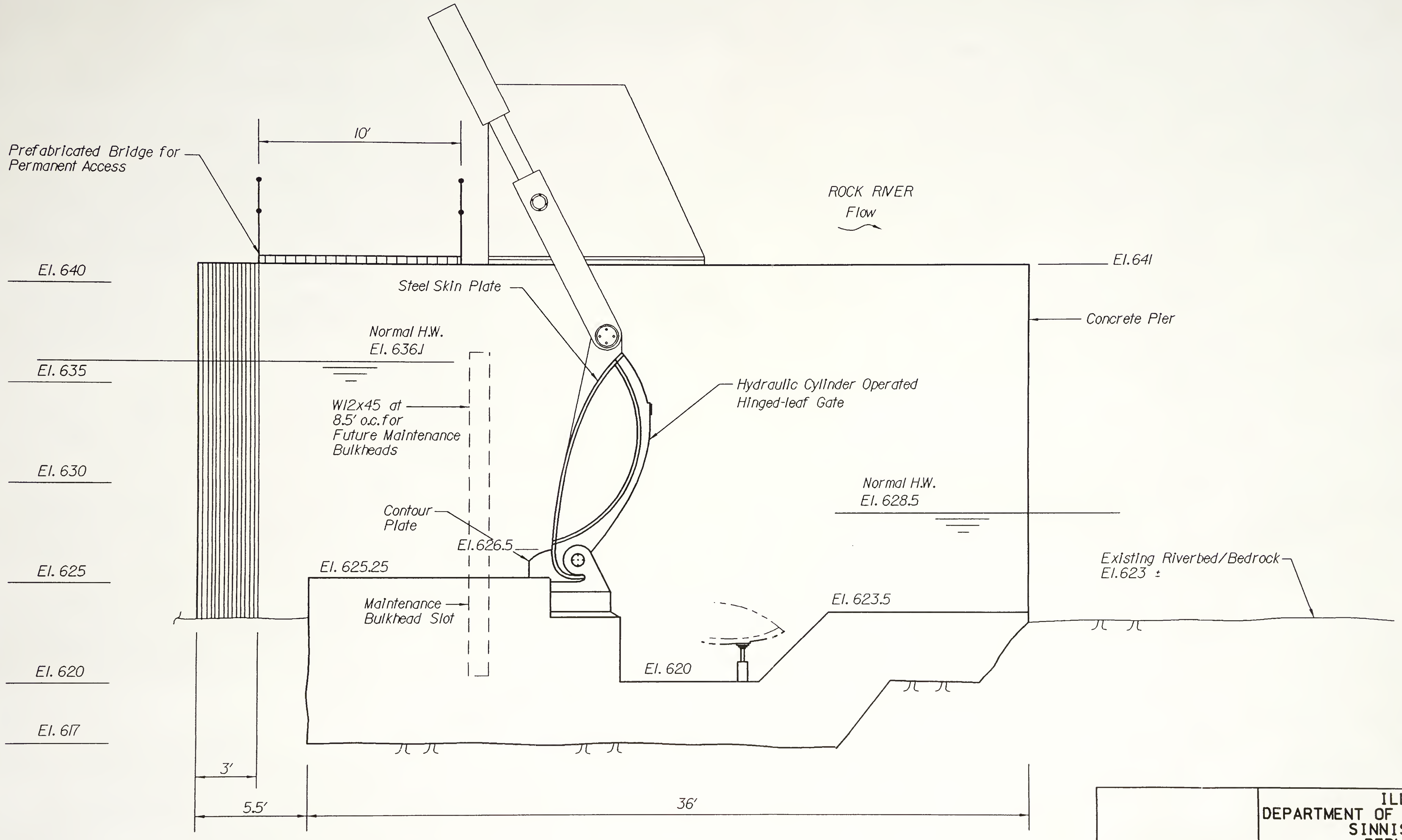
ALTERNATIVE 1:
HYDRAULIC CYLINDER
OPERATED HINGED-LEAF GATES
CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 5

07/13/94 PRH

1731014A



CROSS SECTION

Scale 0 2.5 5 Feet

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

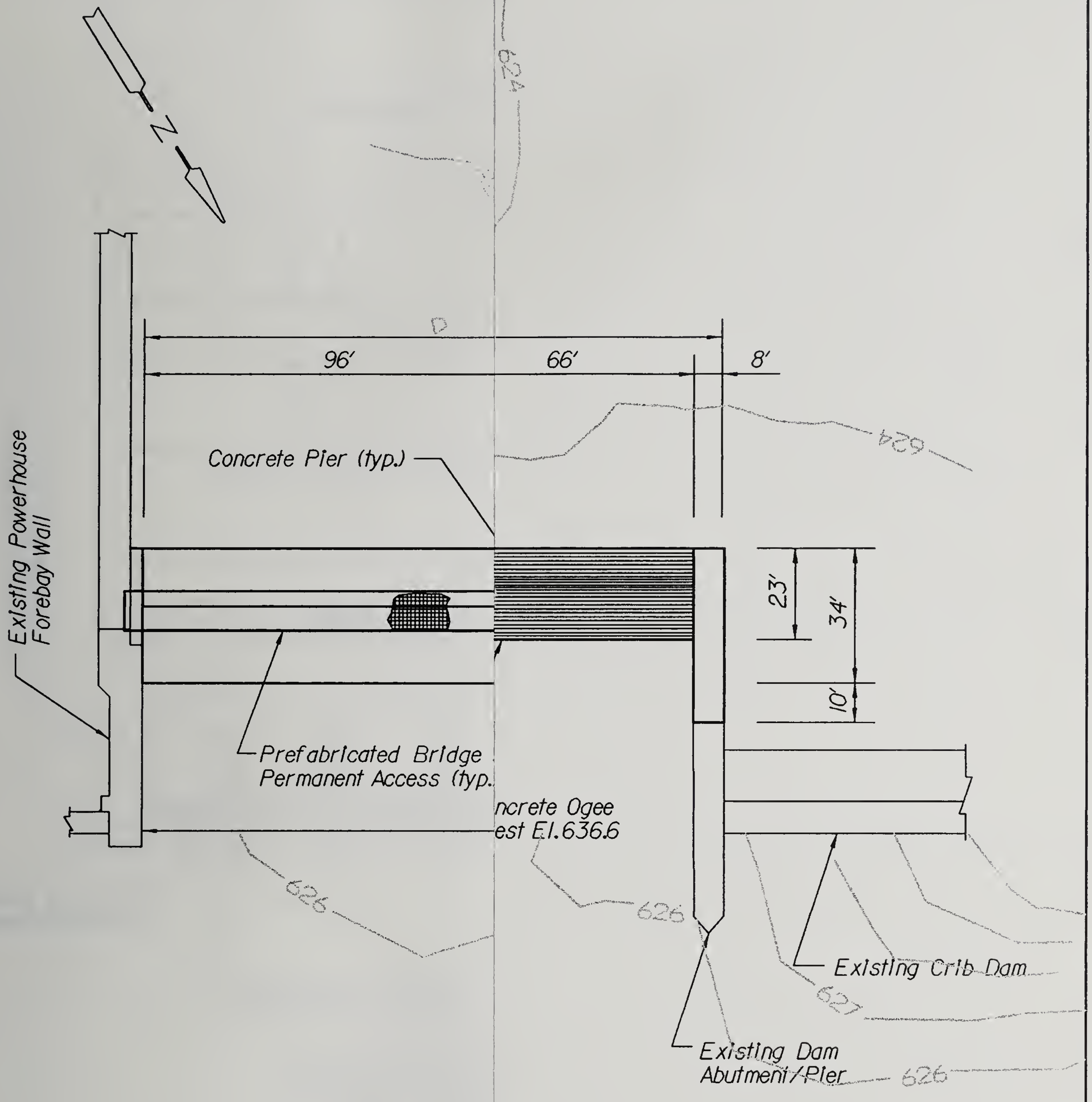
ALTERNATIVE 1:
HYDRAULIC CYLINDER
OPERATED HINGED-LEAF GATES
CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 5

07/13/94 PRH

1731014A



ERS, INC.

L ST.

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

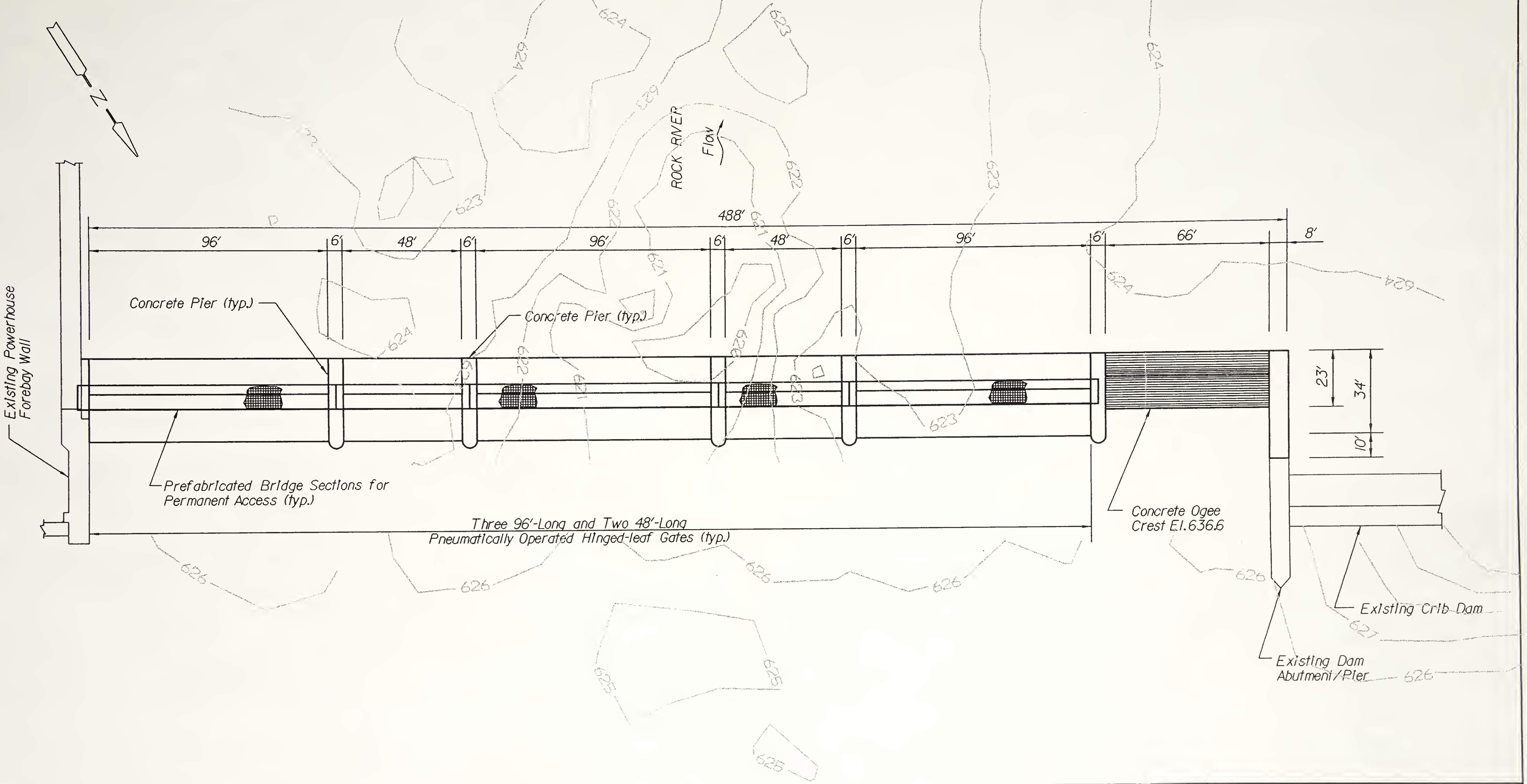
ALTERNATIVE 2:
PNEUMATICALLY OPERATED
HINGED-LEAF GATES
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: NOVEMBER, 1994 FIG. Prelim. 6

11/23/94 PRH

1731029A


N
ROCK RIVER
Flow
488'
96'
6'
48'
6'
96'
6'
48'
6'
96'
6'
66'
8'
23'
34'
10'
Existing Powerhouse Forebay Wall
Concrete Pier (typ.)
Concrete Pier (typ.)
Prefabricated Bridge Sections for Permanent Access (typ.)
Three 96'-Long and Two 48'-Long Pneumatically Operated Hinged-leaf Gates (typ.)
Concrete Ogee Crest El.636.6
Existing Crib Dam
Existing Dam Abutment/Pier
624
623
622
621
624
623
626
625
627

PLAN

Scale 0 20 40 Feet

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

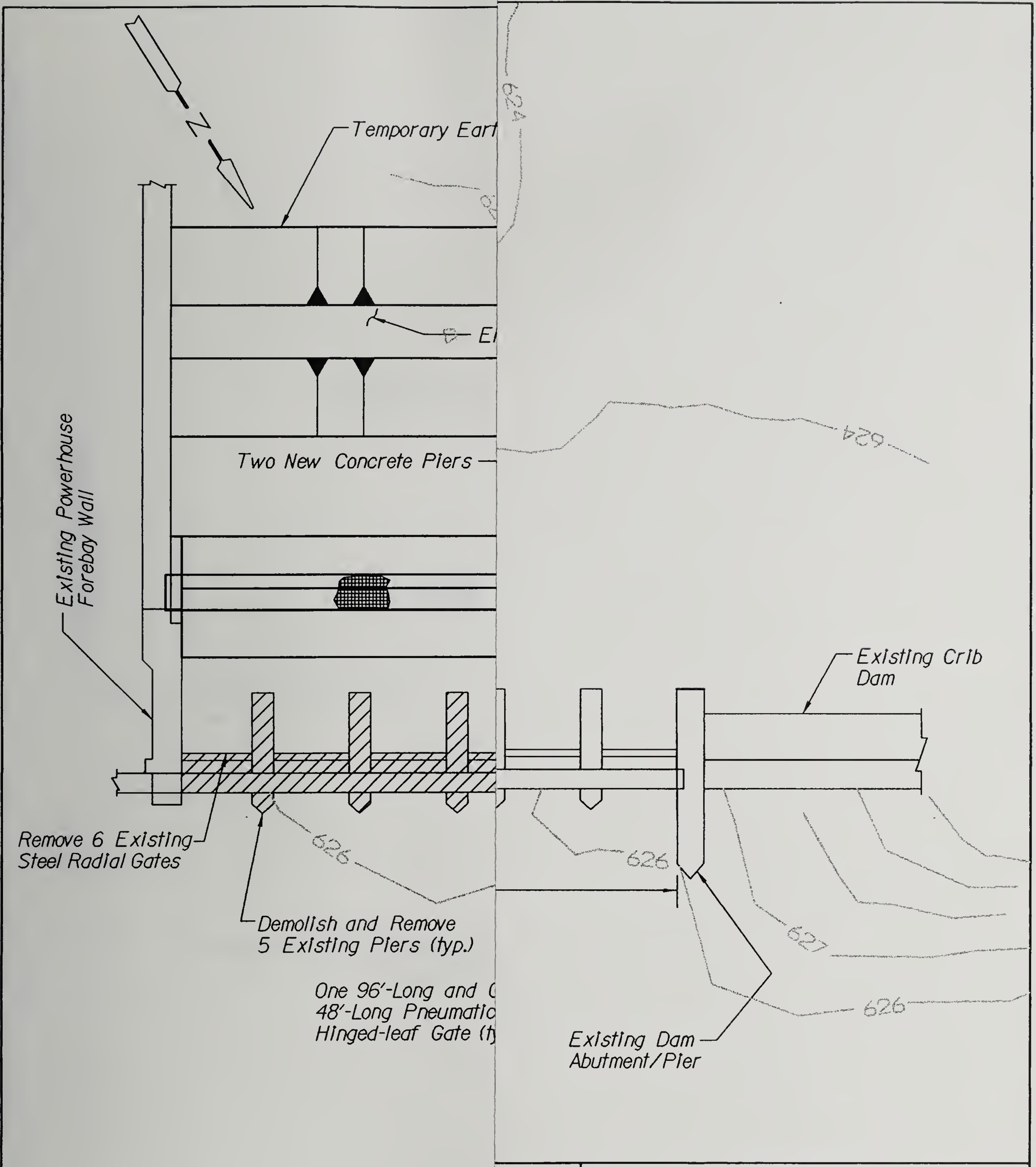
ALTERNATIVE 2:
PNEUMATICALLY OPERATED
HINGED-LEAF GATES
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: NOVEMBER, 1994 FIG. Prelim. 6

11/23/94 PRH

1731029A



N
Temporary Eart
El
Two New Concrete Piers
Existing Powerhouse Forebay Wall
Existing Crib Dam
Remove 6 Existing Steel Radial Gates
Demolish and Remove 5 Existing Piers (typ.)
One 96'-Long and C
48'-Long Pneumatic
Hinged-leaf Gate (t
Existing Dam Abutment/Pier
624
62
624
626
626
627
626

ERS, INC.

L ST.

60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 2:
PNEUMATICALLY OPERATED
HINGED-LEAF GATES

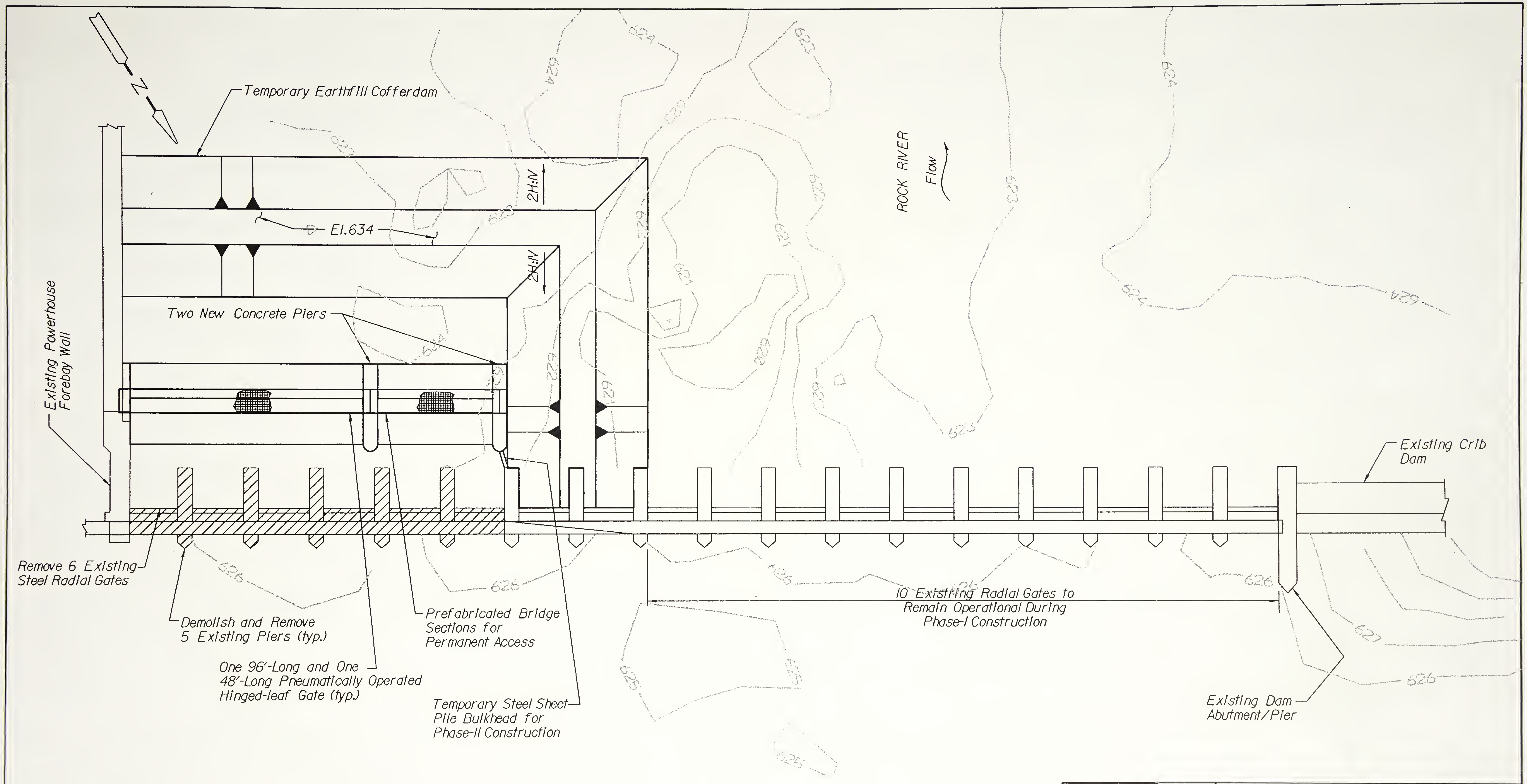
PHASE-I CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: NOVEMBER, 1994 FIG. Prelim. 7

07/13/94 PRH

1731031A


N
Temporary Earthfill Cofferdam
2H:V
El.634
2H:V
Two New Concrete Piers
Existing Powerhouse Forebay Wall
ROCK RIVER
Flow
Existing Crib Dam
Remove 6 Existing Steel Radial Gates
Demolish and Remove 5 Existing Piers (typ.)
Prefabricated Bridge Sections for Permanent Access
One 96'-Long and One 48'-Long Pneumatically Operated Hinged-leaf Gate (typ.)
Temporary Steel Sheet Pile Bulkhead for Phase-II Construction
10 Existing Radial Gates to Remain Operational During Phase-I Construction
Existing Dam Abutment/Pier
624
623
622
621
620
625
626
627

PLAN

Scale 0 20 40 Feet

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 2:
PNEUMATICALLY OPERATED
HINGED-LEAF GATES

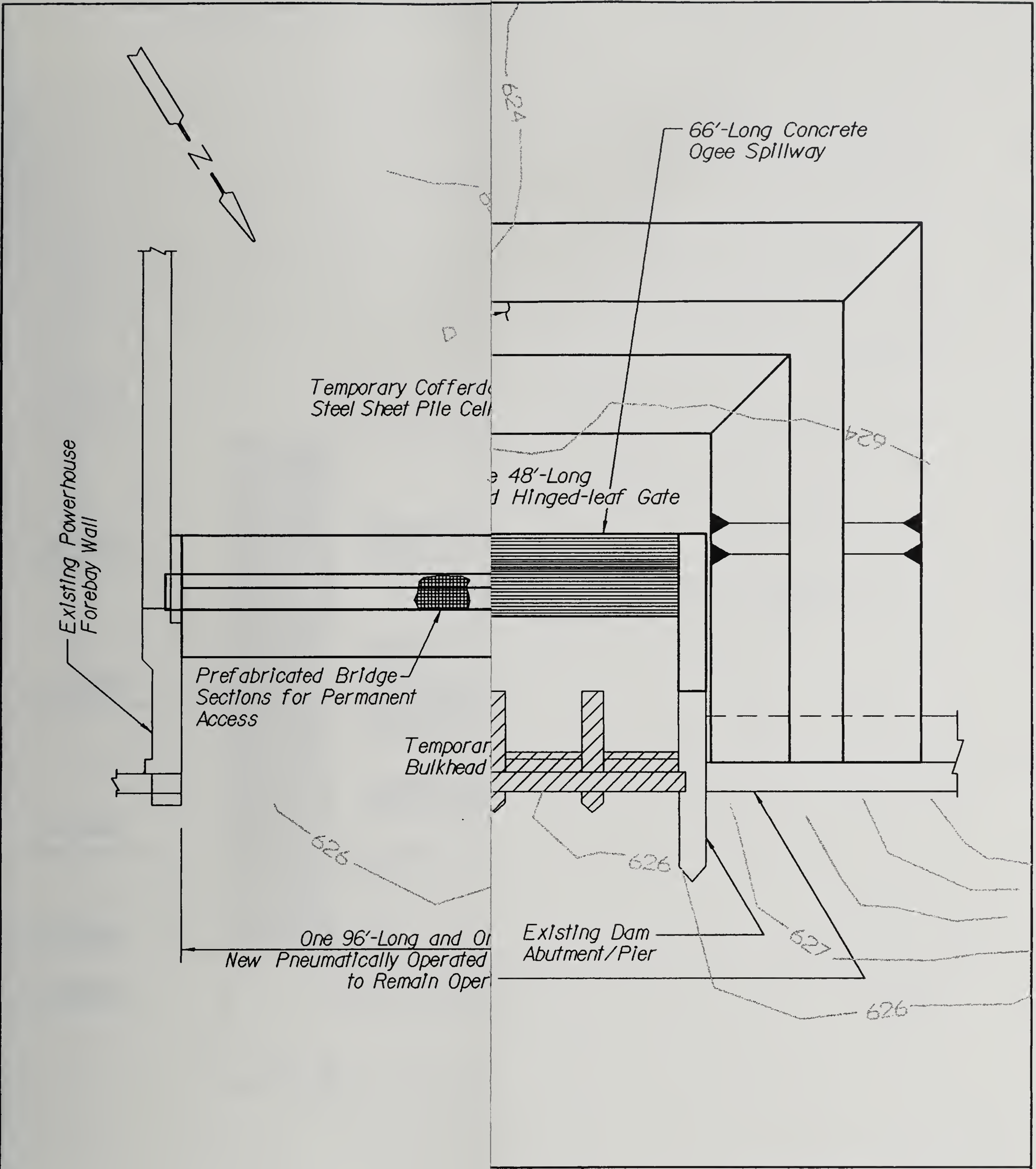
PHASE-I CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: NOVEMBER, 1994 FIG. Prelim. 7

07/13/94 PRH

1731031A



EERS, INC.

AL ST.

60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 2:
PNEUMATICALLY OPERATED
HINGED-LEAF GATES

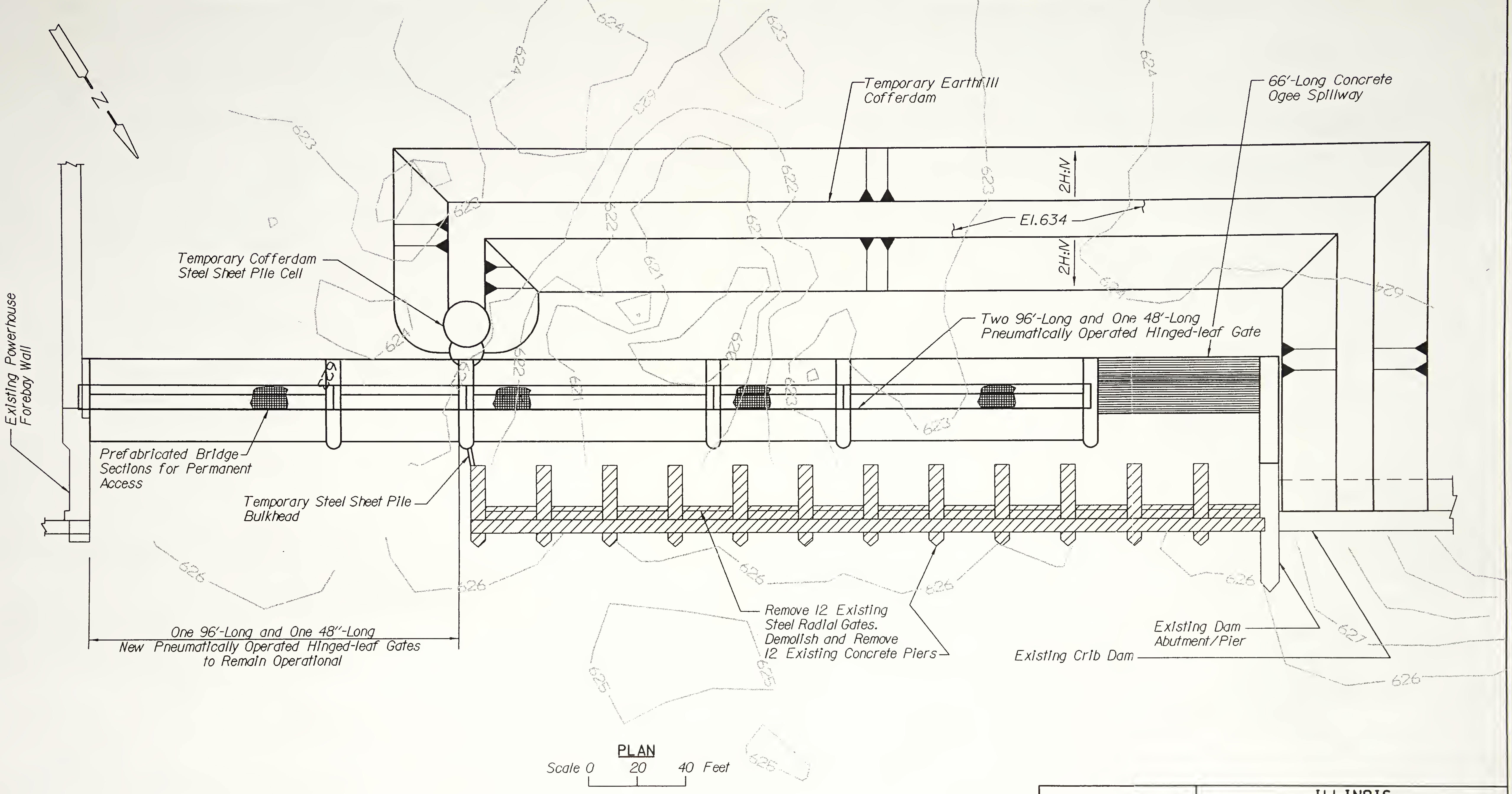
PHASE-II CONSTRUCTION PLAN

DRAWN BY: PRH   CHECKED BY: QF

DATE: NOVEMBER, 1994   FIG. Prelim. 8

07/13/94 PRH

1731032A


N
Existing Powerhouse Forebay Wall
Temporary Cofferdam Steel Sheet Pile Cell
Temporary Earthfill Cofferdam
66'-Long Concrete Ogee Spillway
2H:1V
El.634
2H:1V
Two 96'-Long and One 48'-Long Pneumatically Operated Hinged-leaf Gate
Prefabricated Bridge Sections for Permanent Access
Temporary Steel Sheet Pile Bulkhead
One 96'-Long and One 48"-Long New Pneumatically Operated Hinged-leaf Gates to Remain Operational
Remove 12 Existing Steel Radial Gates. Demolish and Remove 12 Existing Concrete Piers
Existing Dam Abutment/Pier
Existing Crib Dam
624
623
622
621
620
625
626
627
Scale 0 20 40 Feet

PLAN

COLLINS ENGINEERS, INC.
165 N. CANAL ST.
CHICAGO, IL. 60606

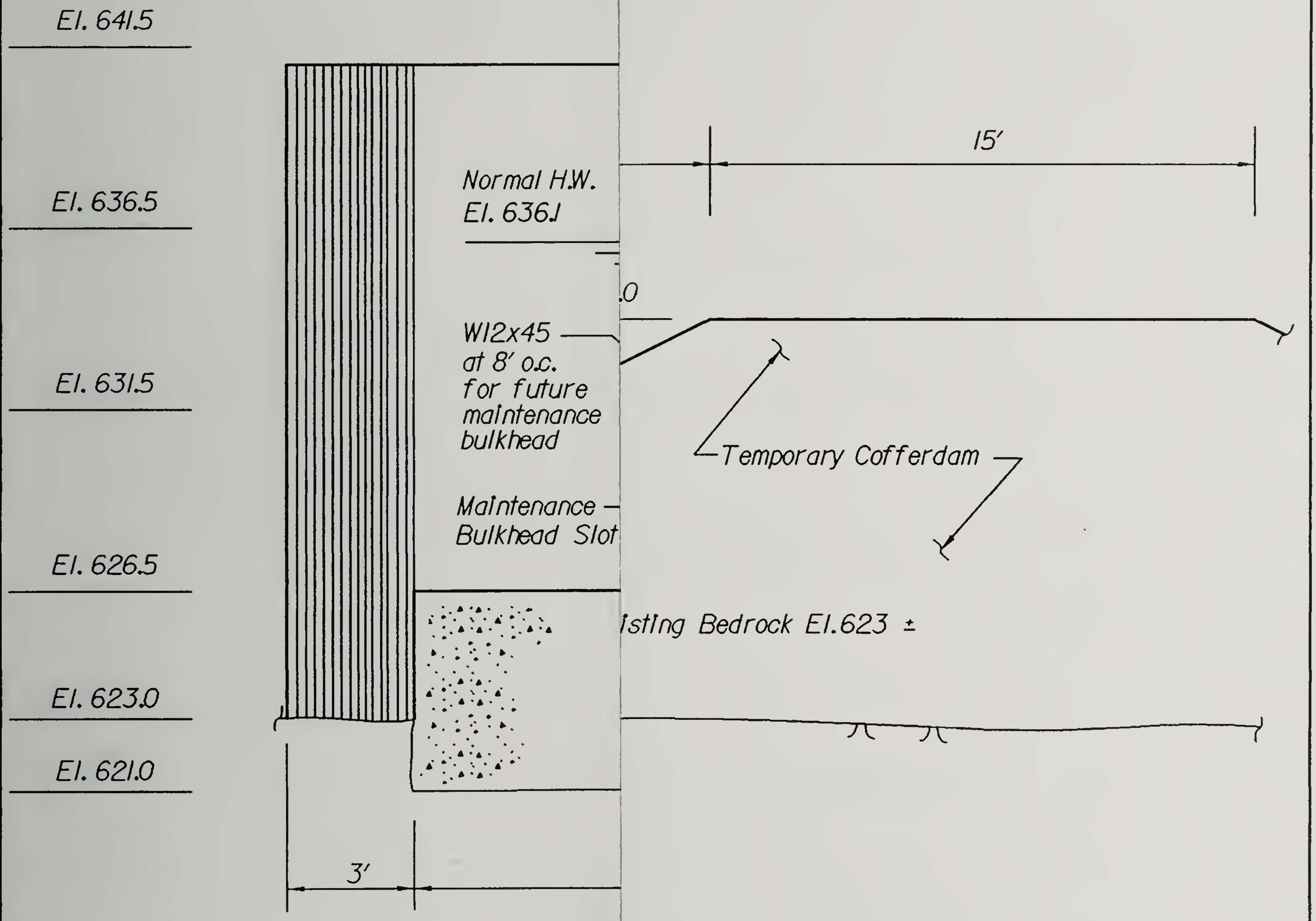
ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 2:
PNEUMATICALLY OPERATED
HINGED-LEAF GATES
PHASE-II CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: NOVEMBER, 1994 FIG. Prelim. 8

07/13/94 PRH
1731032A



EERS, INC.

L ST.

60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 2:
PNEUMATICALLY OPERATED
HINGED-LEAF GATES

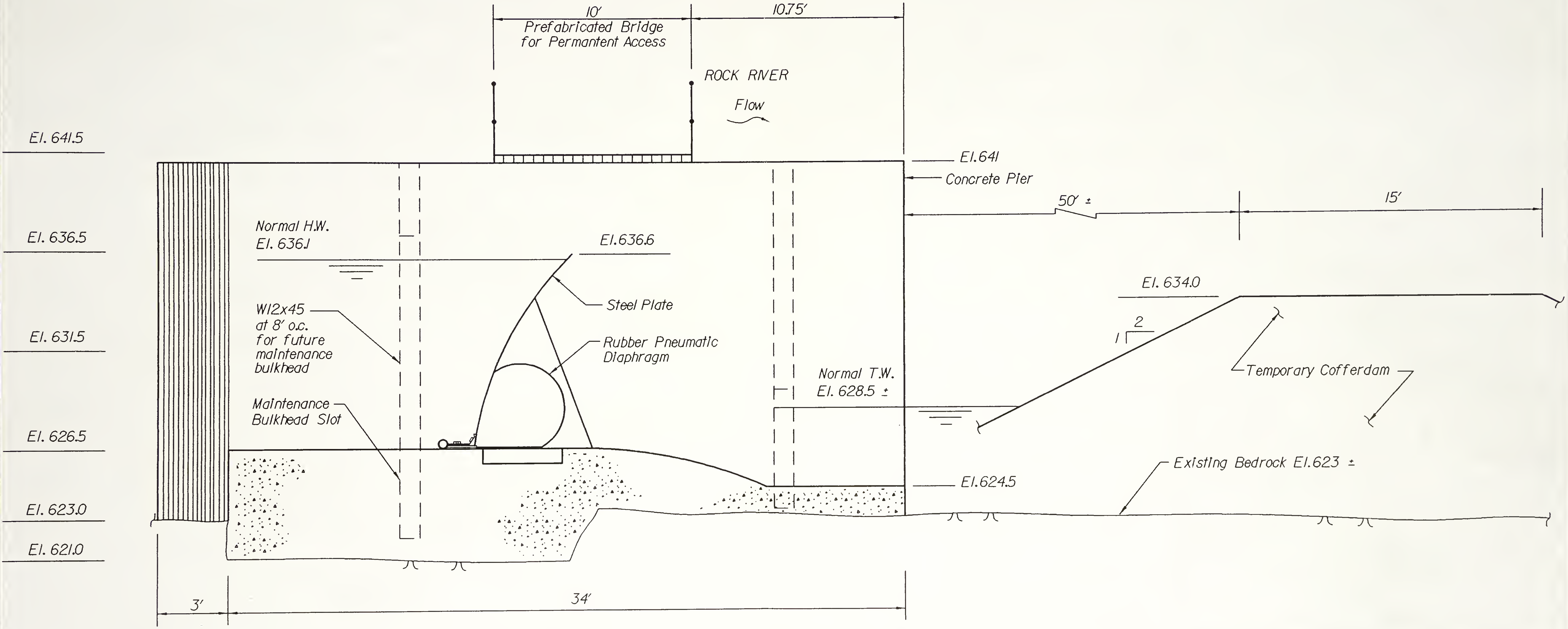
CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 9

11/23/94 PRH

1731030A



CROSS SECTION

Scale 0 2.5 5 Feet

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

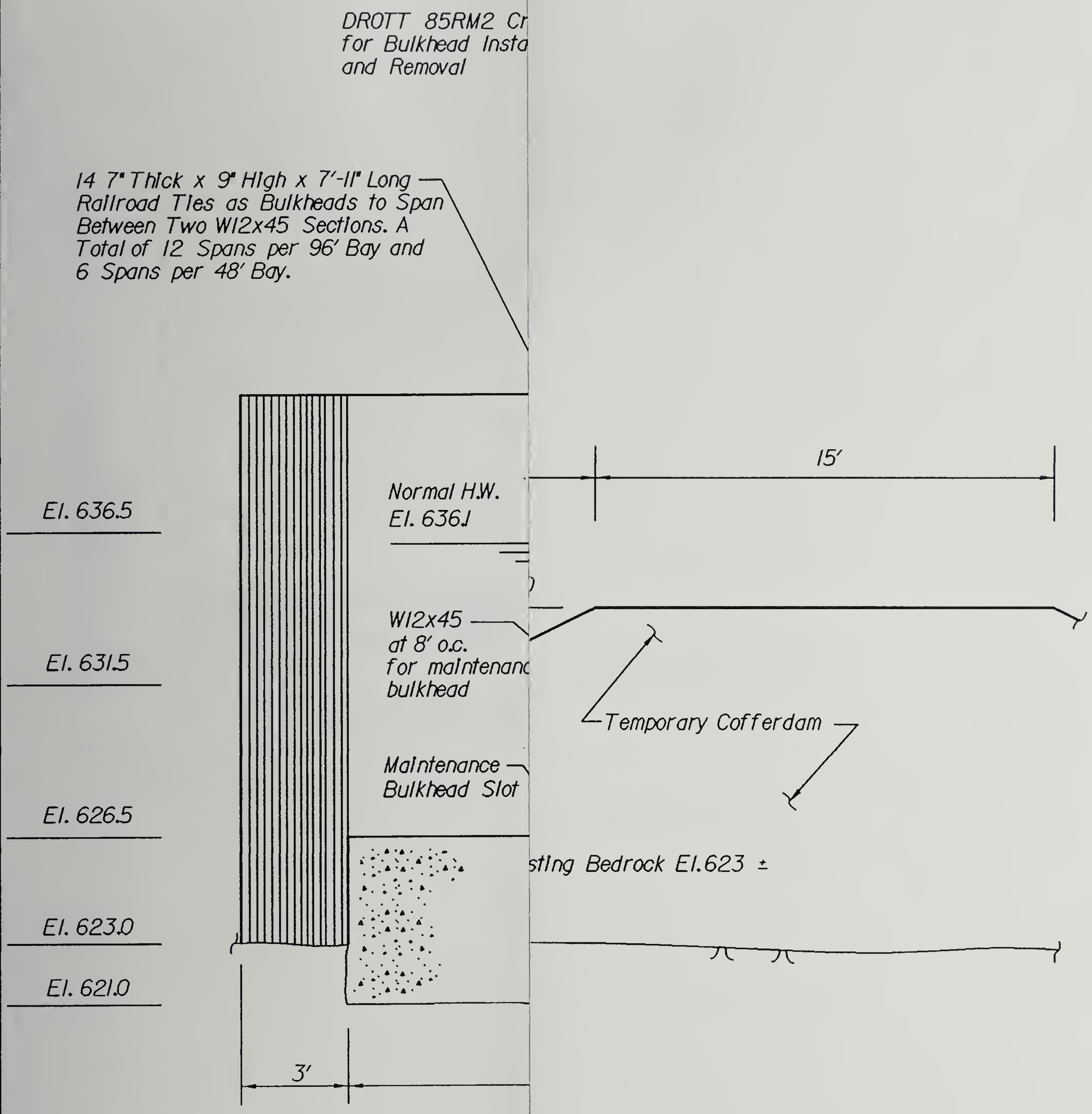
ALTERNATIVE 2:
PNEUMATICALLY OPERATED
HINGED-LEAF GATES
CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 9

11/23/94 PRH

1731030A



ERS, INC.

. ST.

0606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

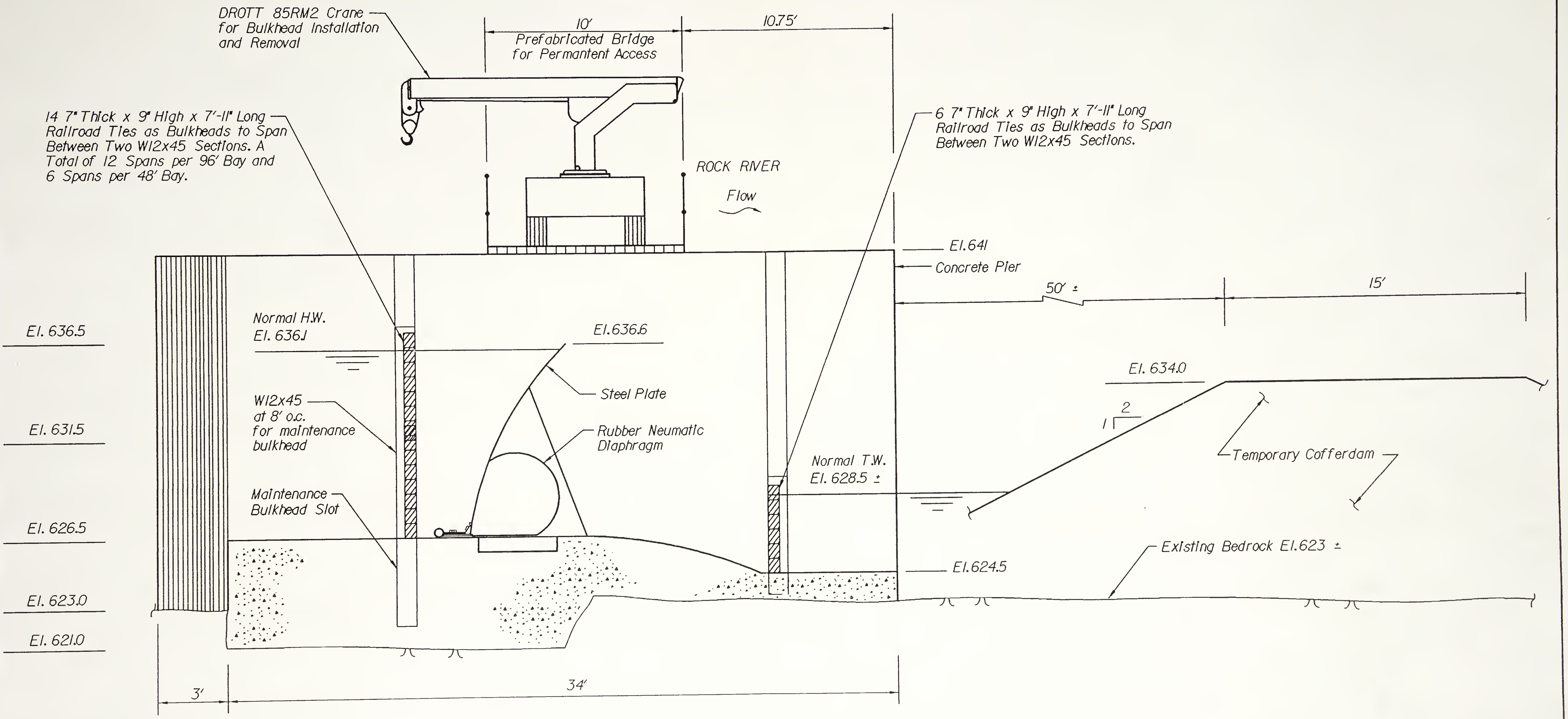
ALTERNATIVE 2:
PNEUMATICALLY OPERATED
HINGED-LEAF GATES
MAINTENANCE BULKHEAD

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 10

11/23/94 PRH

1731033A


DROTT 85RM2 Crane for Bulkhead Installation and Removal
10' Prefabricated Bridge for Permanent Access
10.75'
14 7" Thick x 9" High x 7'-11" Long Railroad Ties as Bulkheads to Span Between Two W12x45 Sections. A Total of 12 Spans per 96' Bay and 6 Spans per 48' Bay.
6 7" Thick x 9" High x 7'-11" Long Railroad Ties as Bulkheads to Span Between Two W12x45 Sections.
ROCK RIVER
Flow
El. 641
Concrete Pier
50' ±
15'
El. 636.5
El. 631.5
El. 626.5
El. 623.0
El. 621.0
Normal H.W. El. 636.1
El. 636.6
Steel Plate
W12x45 at 8' o.c. for maintenance bulkhead
Rubber Neumatic Diaphragm
Maintenance Bulkhead Slot
El. 634.0
2
1
Temporary Cofferdam
Normal T.W. El. 628.5 ±
El. 624.5
Existing Bedrock El. 623 ±
3'
34'

CROSS SECTION

Scale 0 2.5 5 Feet

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 2:
PNEUMATICALLY OPERATED
HINGED-LEAF GATES

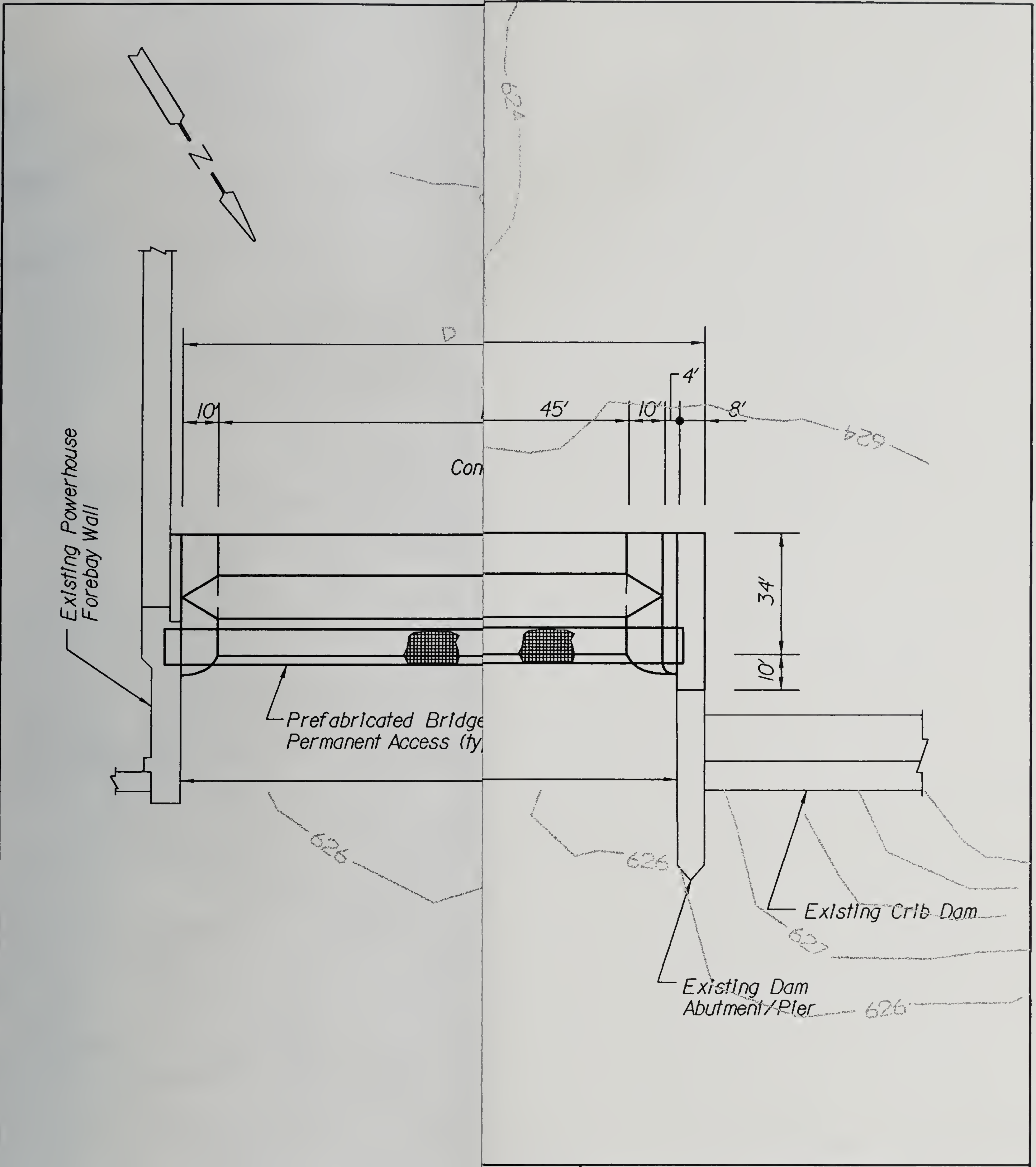
MAINTENANCE BULKHEAD

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 10

11/23/94 PRH

1731033A



EERS, INC.

AL ST.

. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 3:
RUBBER DAM

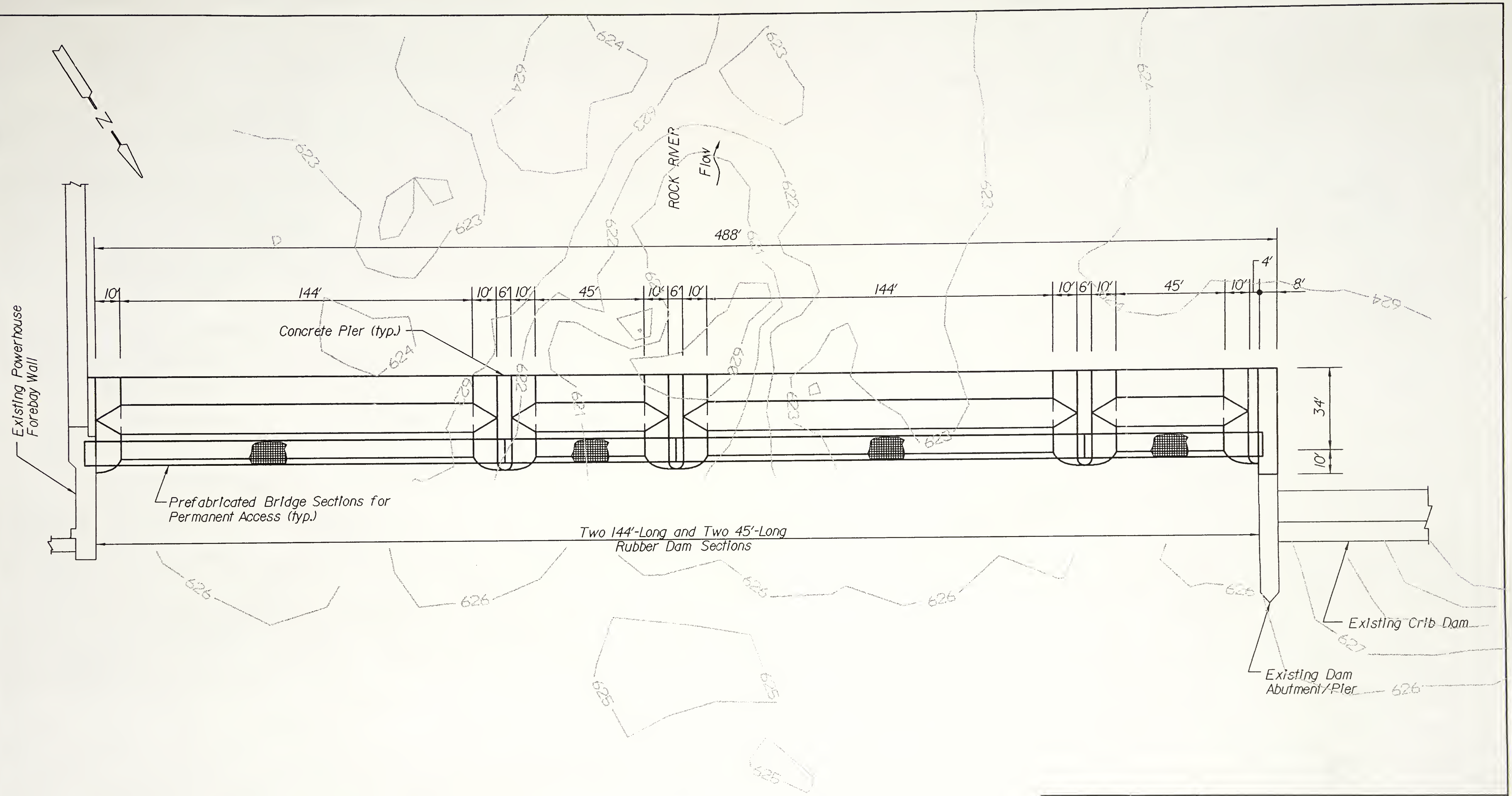
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 11

07/13/94 PRH

1731006A


N
ROCK RIVER
Flow
488'
10'
144'
10'
6'
10'
45'
10'
6'
10'
144'
10'
6'
10'
45'
10'
4'
8'
34'
10'
Concrete Pier (typ.)
Existing Powerhouse Forebay Wall
Prefabricated Bridge Sections for Permanent Access (typ.)
Two 144'-Long and Two 45'-Long Rubber Dam Sections
Existing Crib Dam
Existing Dam Abutment/Pier
624
623
622
621
625
626
627

PLAN

Scale 0 20 40 Feet

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 3:
RUBBER DAM

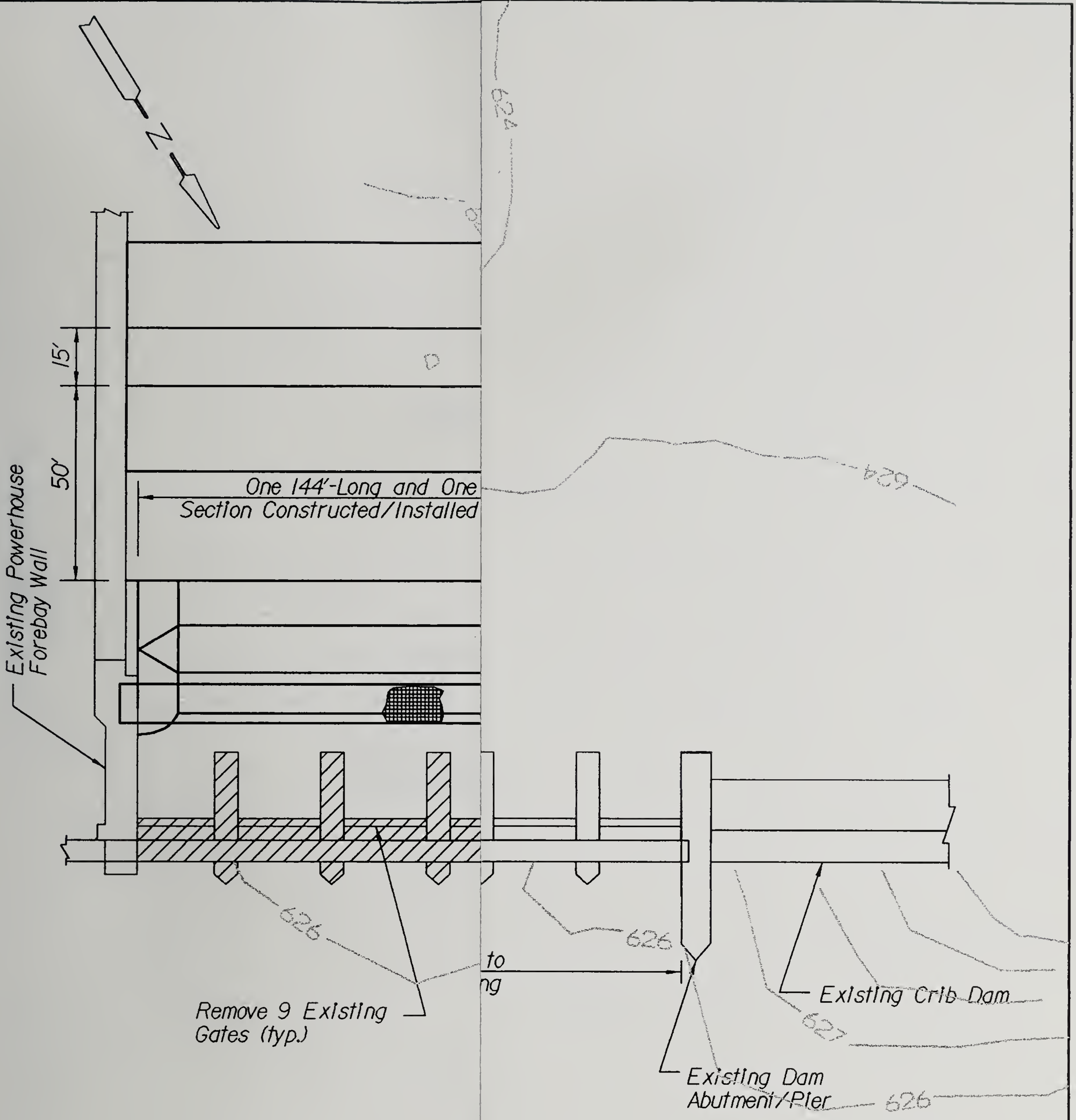
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 11

07/13/94 PRH

1731006A


N
15'
50'
Existing Powerhouse Forebay Wall
One 144'-Long and One
Section Constructed/Installed
D
624
624
626
626
627
626
to
ng
Remove 9 Existing Gates (typ.)
Existing Crib Dam
Existing Dam Abutment/Pier

ERS, INC.

L ST.

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 3:
RUBBER DAM

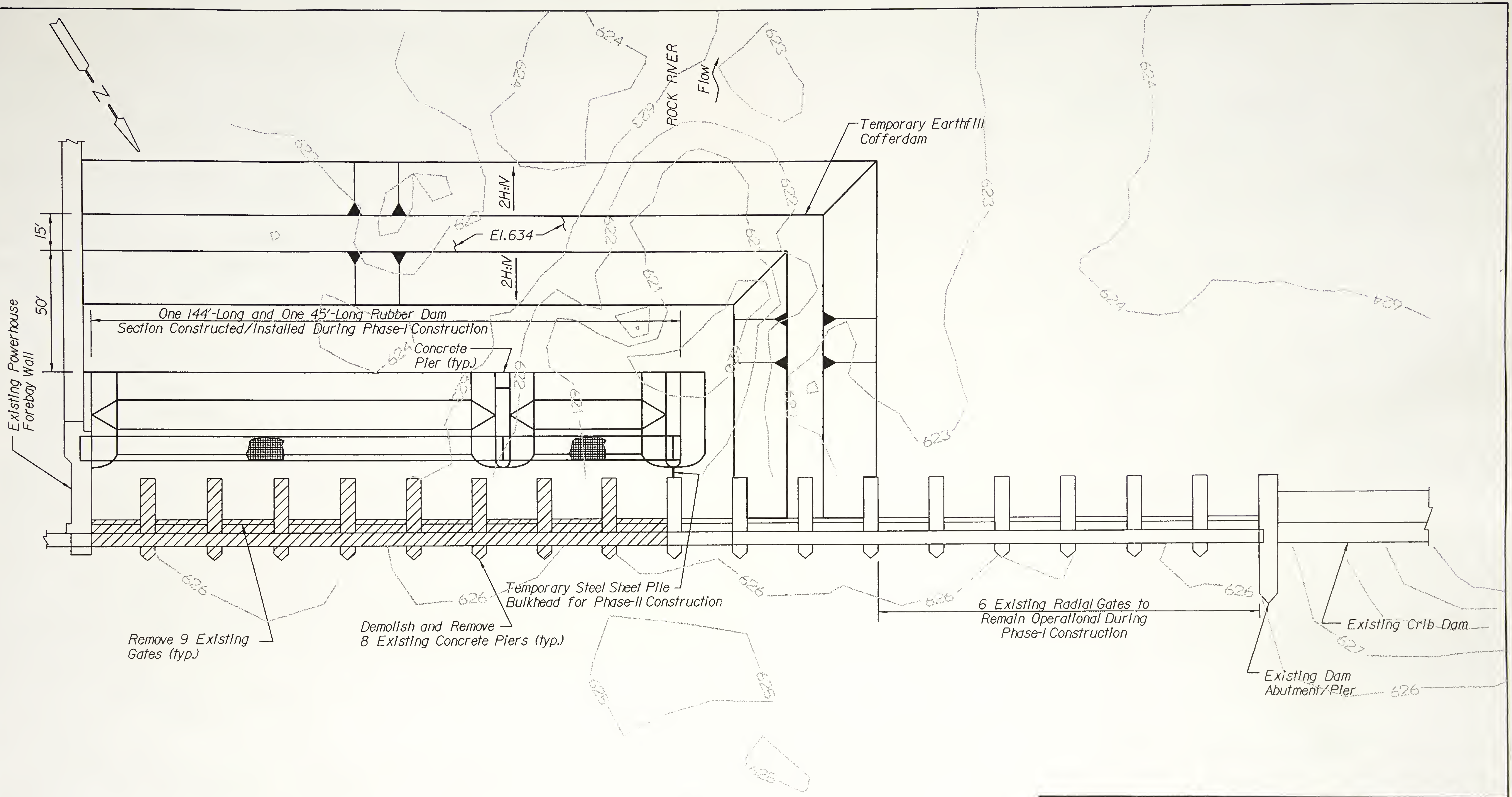
PHASE-I CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 12

07/13/94 PRH

1731023A


N
ROCK RIVER
Flow
Temporary Earthfill Cofferdam
El.634
2H:1V
2H:1V
15'
50'
Existing Powerhouse Forebay Wall
One 144'-Long and One 45'-Long Rubber Dam Section Constructed/Installed During Phase-I Construction
Concrete Pier (typ.)
Temporary Steel Sheet Pile Bulkhead for Phase-II Construction
Remove 9 Existing Gates (typ.)
Demolish and Remove 8 Existing Concrete Piers (typ.)
6 Existing Radial Gates to Remain Operational During Phase-I Construction
Existing Crib Dam
Existing Dam Abutment/Pier
624
624
623
624
623
622
622
622
621
621
623
624
624
623
624
622
622
621
623
622
626
626
626
626
626
627
626
625
625
625

PLAN

Scale 0 20 40 Feet

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ALTERNATIVE 3:
RUBBER DAM

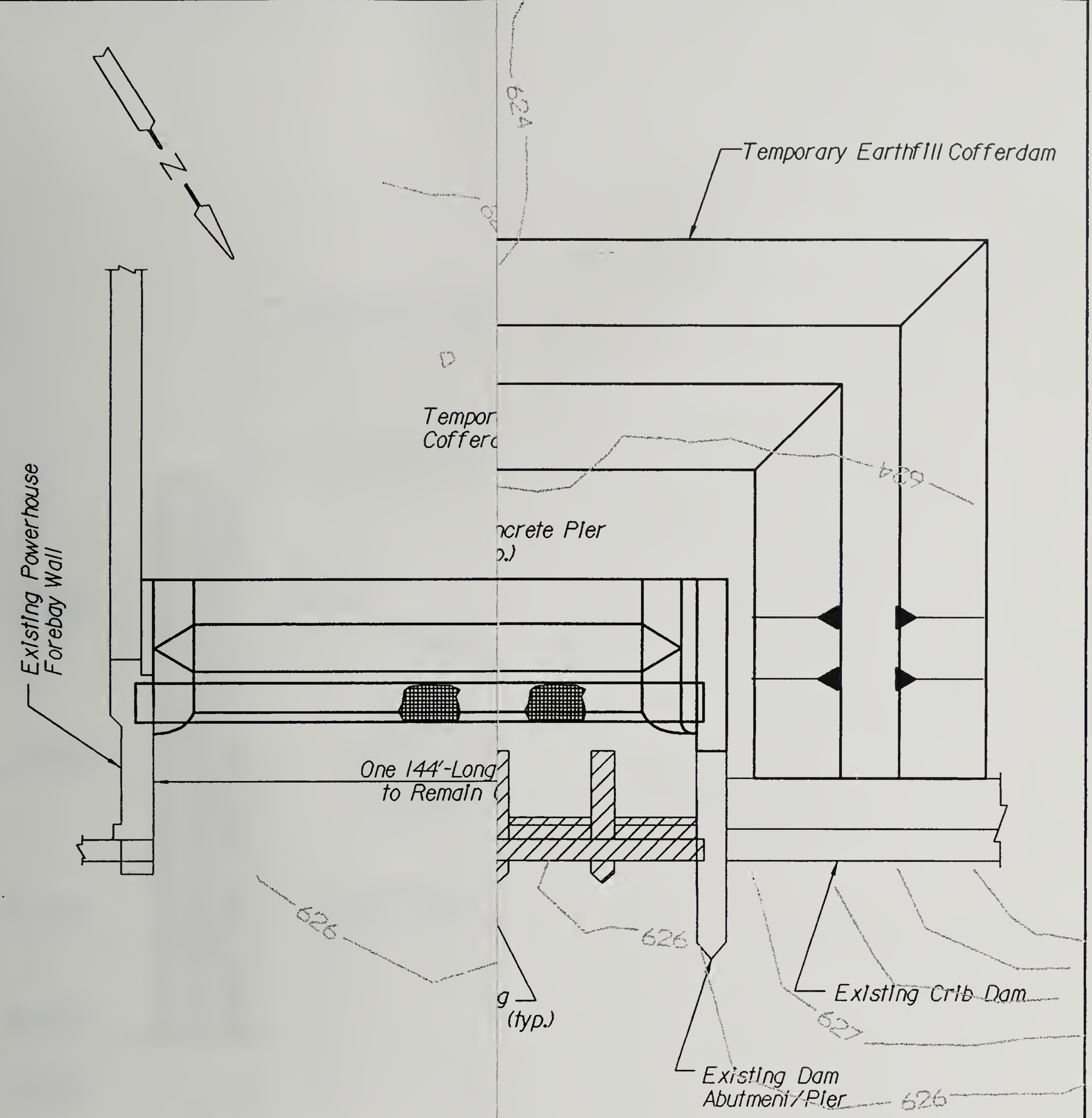
PHASE-I CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 12

07/13/94 PRH

1731023A



ERS, INC.

L ST.

60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 3:
RUBBER DAM

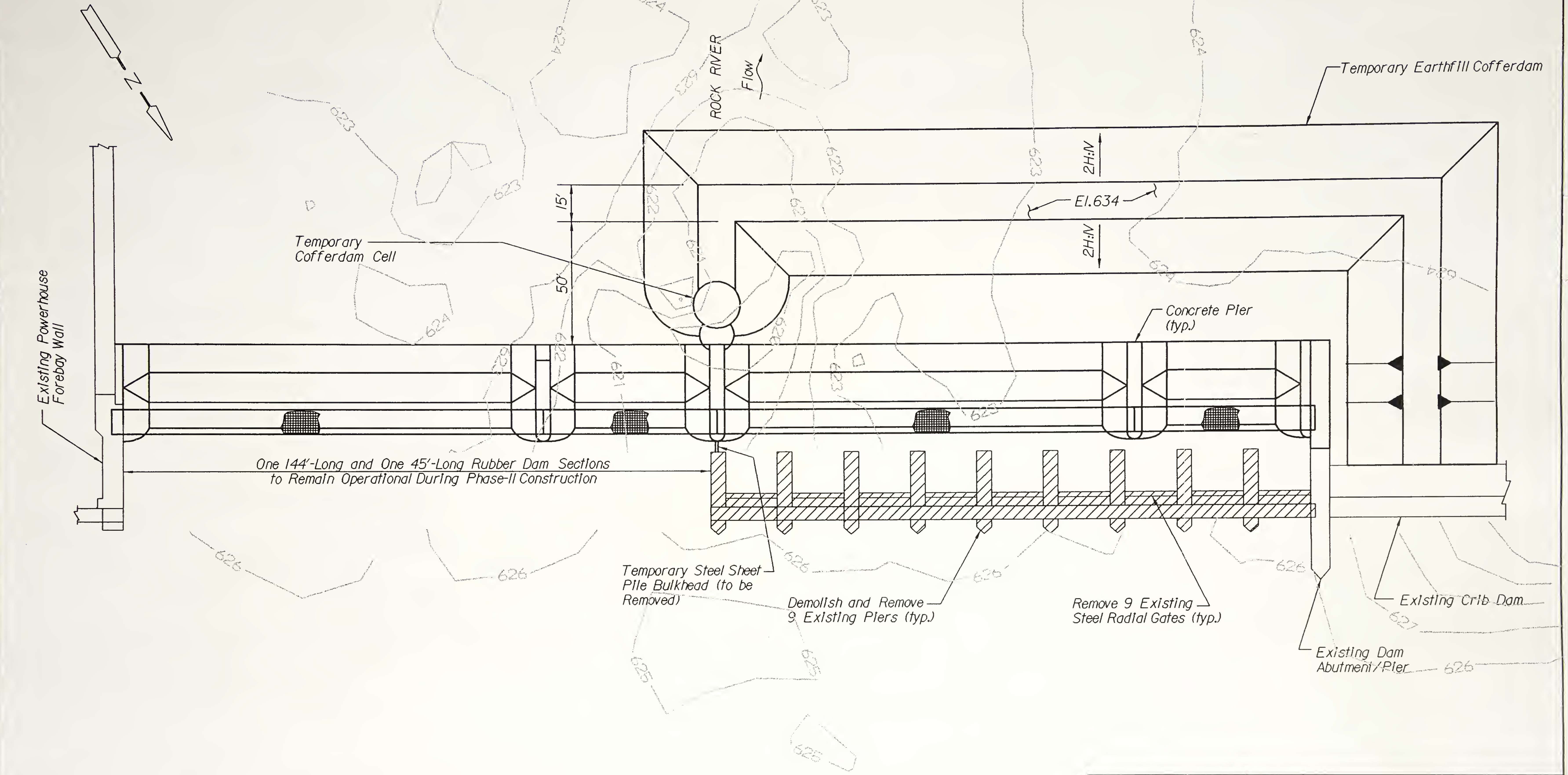
PHASE-II CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 13

07/13/94 PRH

1731024A



N
ROCK RIVER
Flow
Temporary Earthfill Cofferdam
2H:1V
El.634
2H:1V
15'
50'
Temporary Cofferdam Cell
Existing Powerhouse Forebay Wall
Concrete Pier (typ.)
One 144'-Long and One 45'-Long Rubber Dam Sections to Remain Operational During Phase-II Construction
Temporary Steel Sheet Pile Bulkhead (to be Removed)
Demolish and Remove 9 Existing Piers (typ.)
Remove 9 Existing Steel Radial Gates (typ.)
Existing Crib Dam
Existing Dam Abutment/Pier
624
623
622
621
620
625
626
627

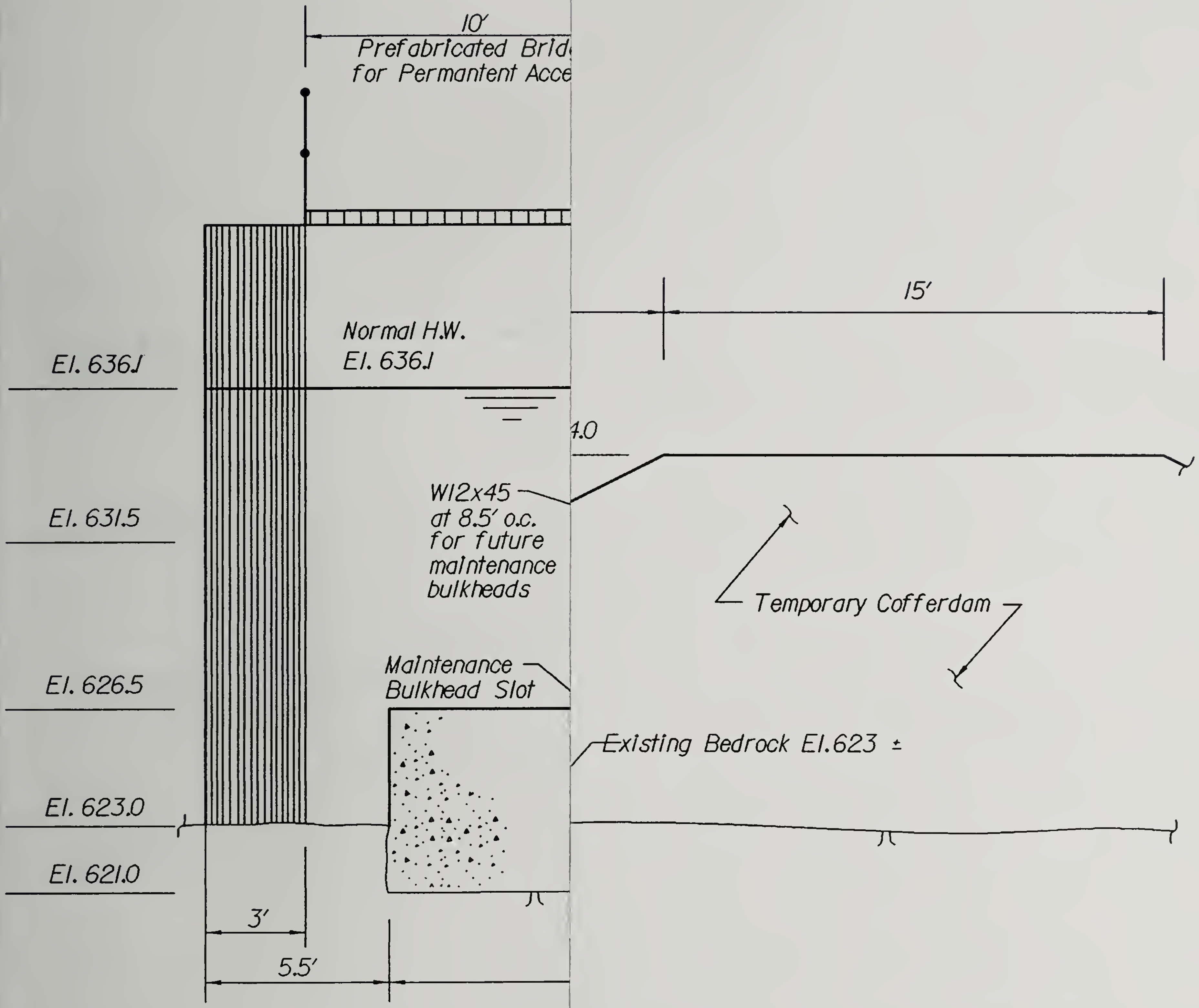
PLAN

Scale 0 20 40 Feet

COLLINS ENGINEERS, INC. 165 N. CANAL ST. CHICAGO, IL. 60606	ILLINOIS DEPARTMENT OF NATURAL RESOURCES SINNISIPPI DAM REPLACEMENT
	ALTERNATIVE 3: RUBBER DAM
	PHASE-II CONSTRUCTION PLAN
	DRAWN BY: PRH CHECKED BY: QF
	DATE: AUGUST, 1994 FIG. Prelim. 13

07/13/94 PRH

1731024A



EERS, INC.

L ST.

60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 3:
RUBBER DAM

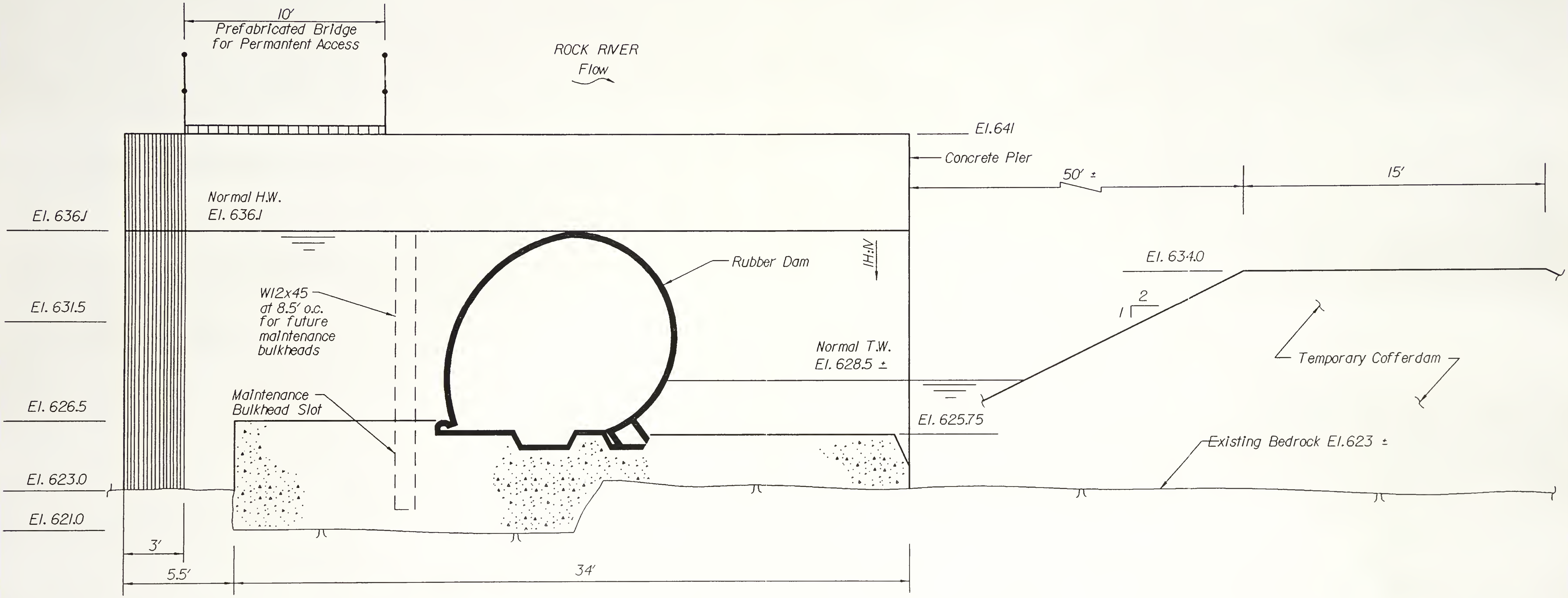
CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 14

07/13/94 PRH

1731012A



CROSS SECTION
Scale: 1"=5'-0"

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

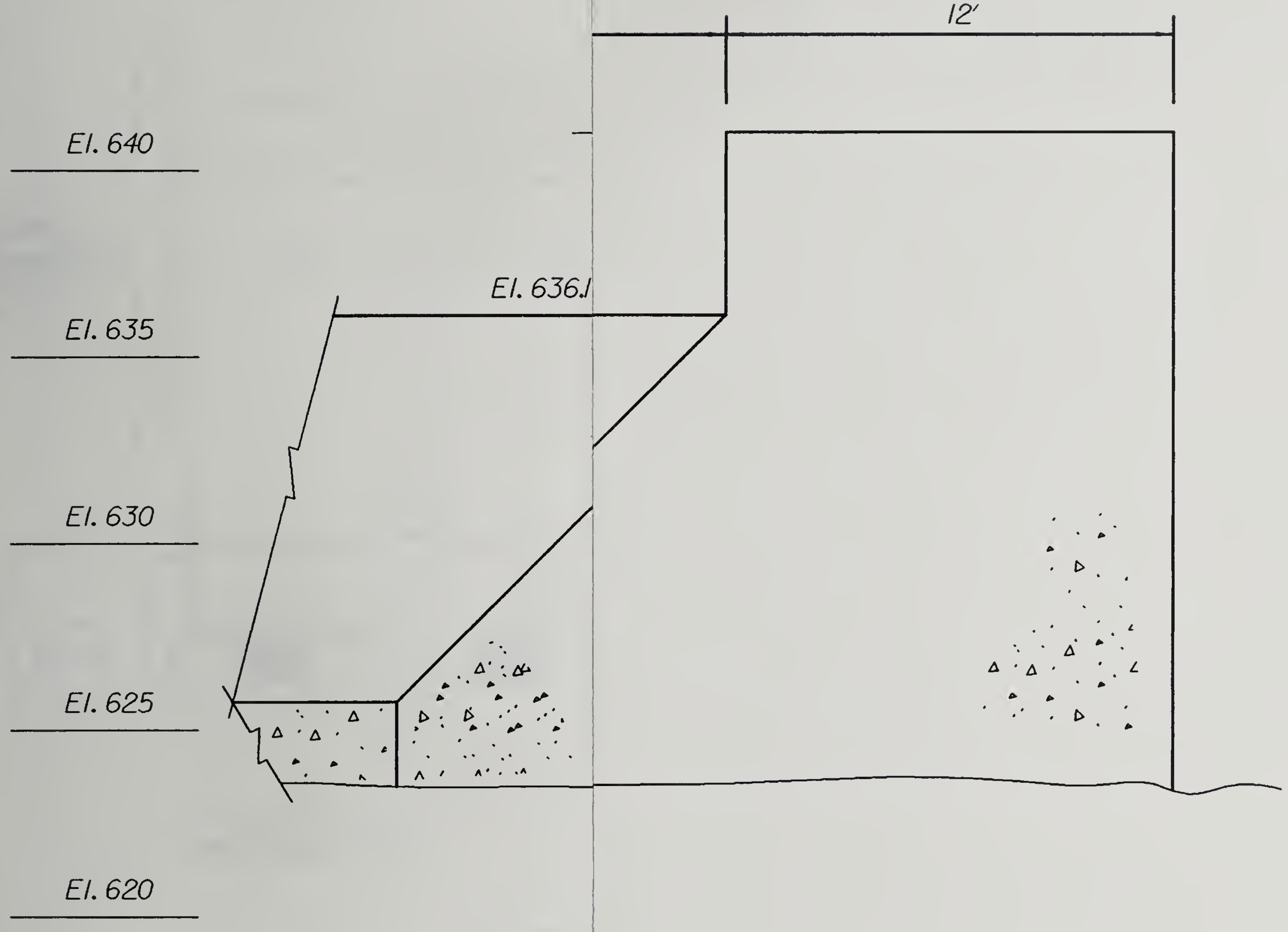
ALTERNATIVE 3:
RUBBER DAM

CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 14

07/13/94 PRH
1731012A



ERS, INC.

L ST.

60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 3:
RUBBER DAM

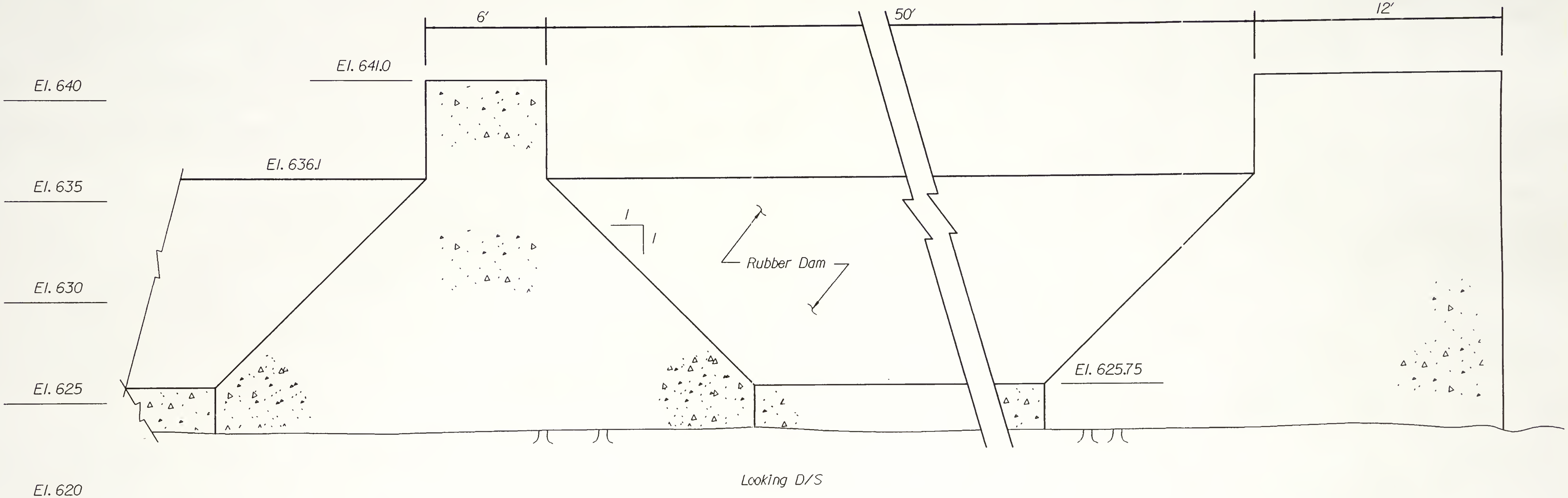
PIER CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 15

07/13/94 PRH

1731010A



CROSS SECTION

Scale 0 2.5 5 Feet

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 3:
RUBBER DAM

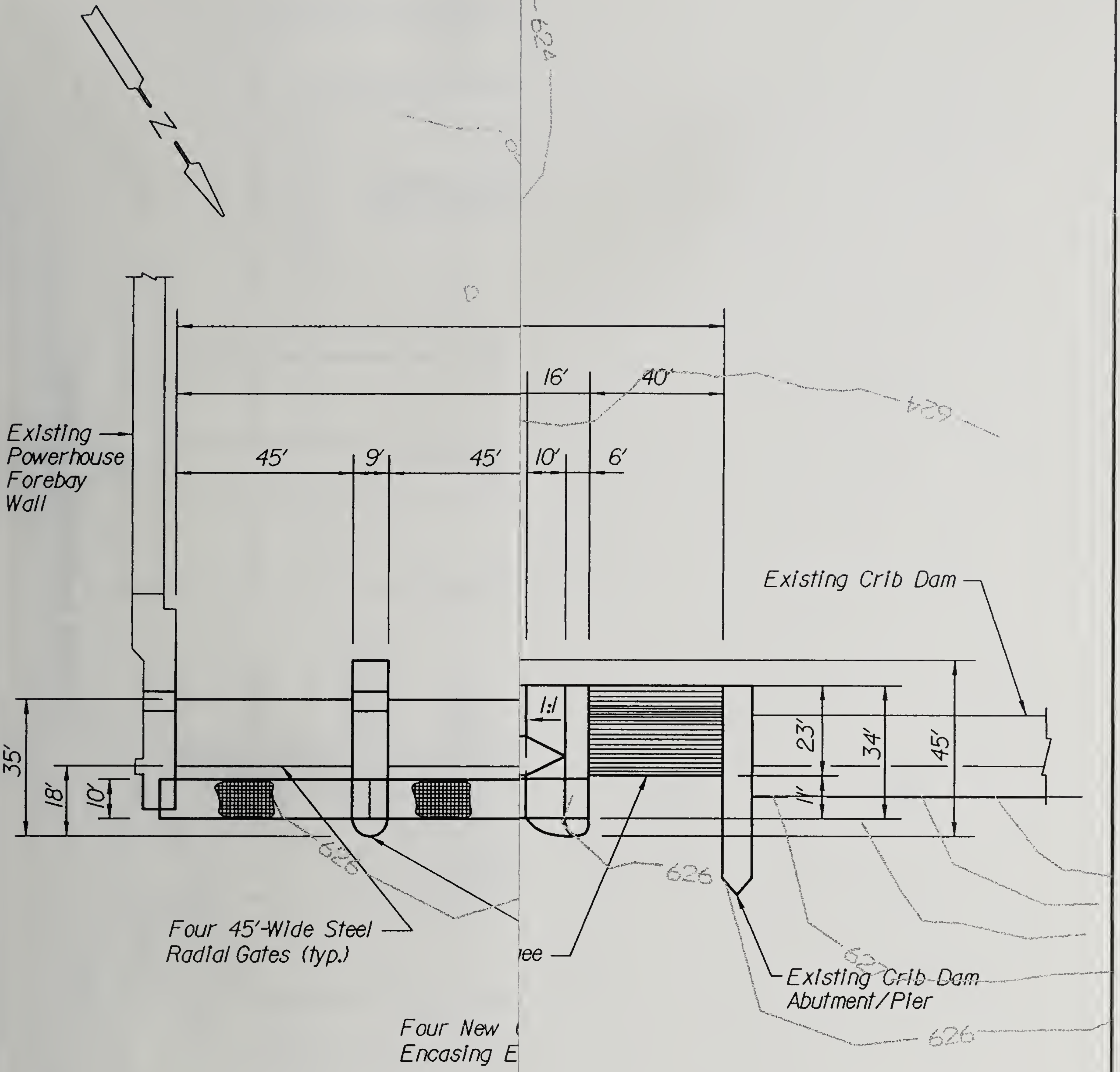
PIER CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 15

07/13/94 PRH

1731010A


N
16′
40′
45′
9′
45′
10′
6′
624
624
Existing Powerhouse Forebay Wall
Existing Crib Dam
1:1
35′
18′
10′
23′
34′
45′
11′
626
626
627
626
Four 45′-Wide Steel Radial Gates (typ.)
ee
Existing Crib Dam Abutment/Pier
Four New
Encasing E

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SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 4: HYBRID OF STEEL RADIAL GATES AND RUBBER DAM

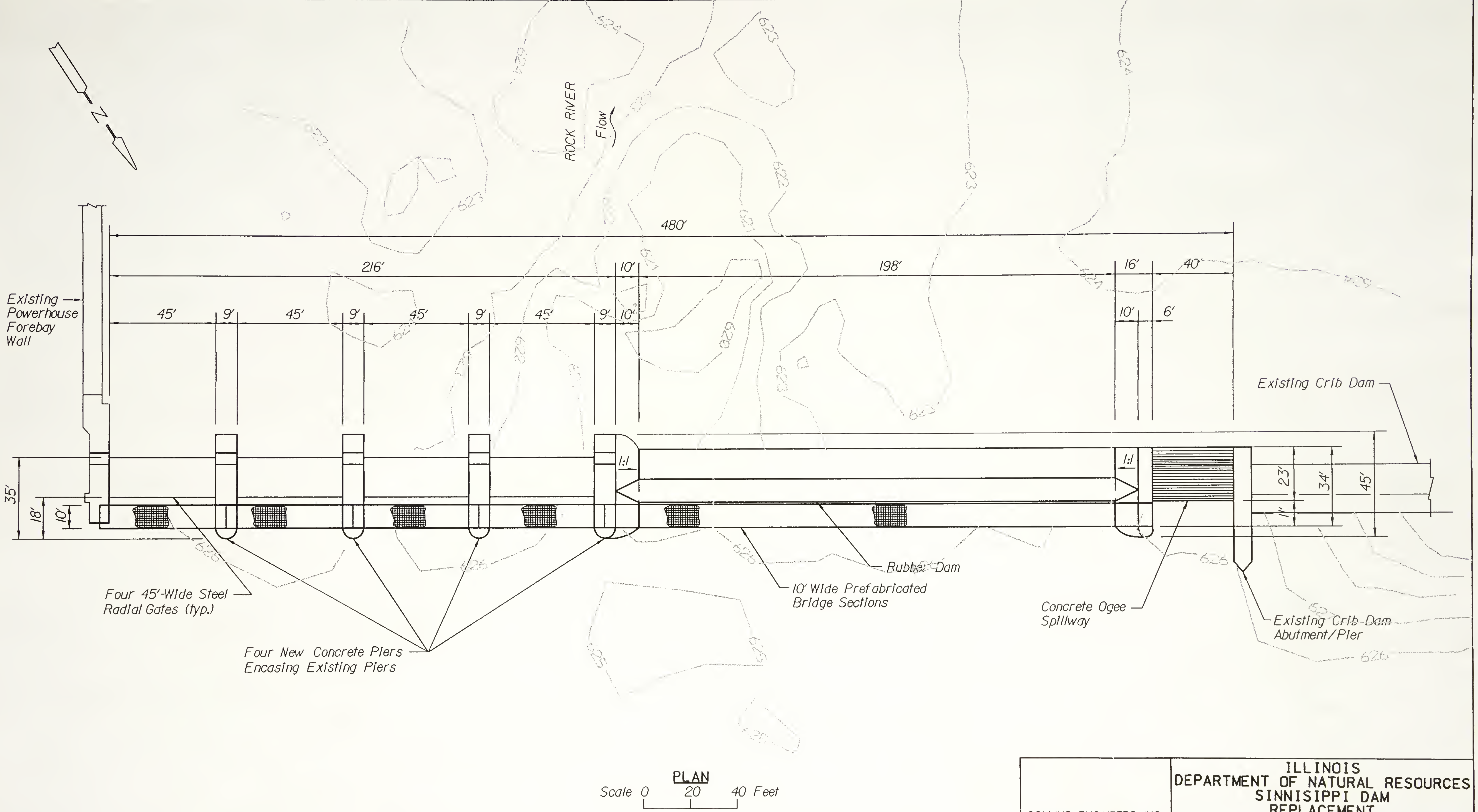
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 16

07/13/94 PRH

1731007A


N
ROCK RIVER
Flow
624
623
622
621
620
625
626
627
480'
216'
10'
198'
16'
40'
45'
9'
10'
6'
Existing Powerhouse Forebay Wall
Existing Crib Dam
1:1
35'
18'
10'
23'
34'
45'
11'
Four 45'-Wide Steel Radial Gates (typ.)
Four New Concrete Piers Encasing Existing Piers
Rubber Dam
10' Wide Prefabricated Bridge Sections
Concrete Ogee Spillway
Existing Crib Dam Abutment/Pier
Scale 0 20 40 Feet

PLAN

COLLINS ENGINEERS, INC.

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 4: HYBRID OF STEEL
RADIAL GATES AND RUBBER DAM

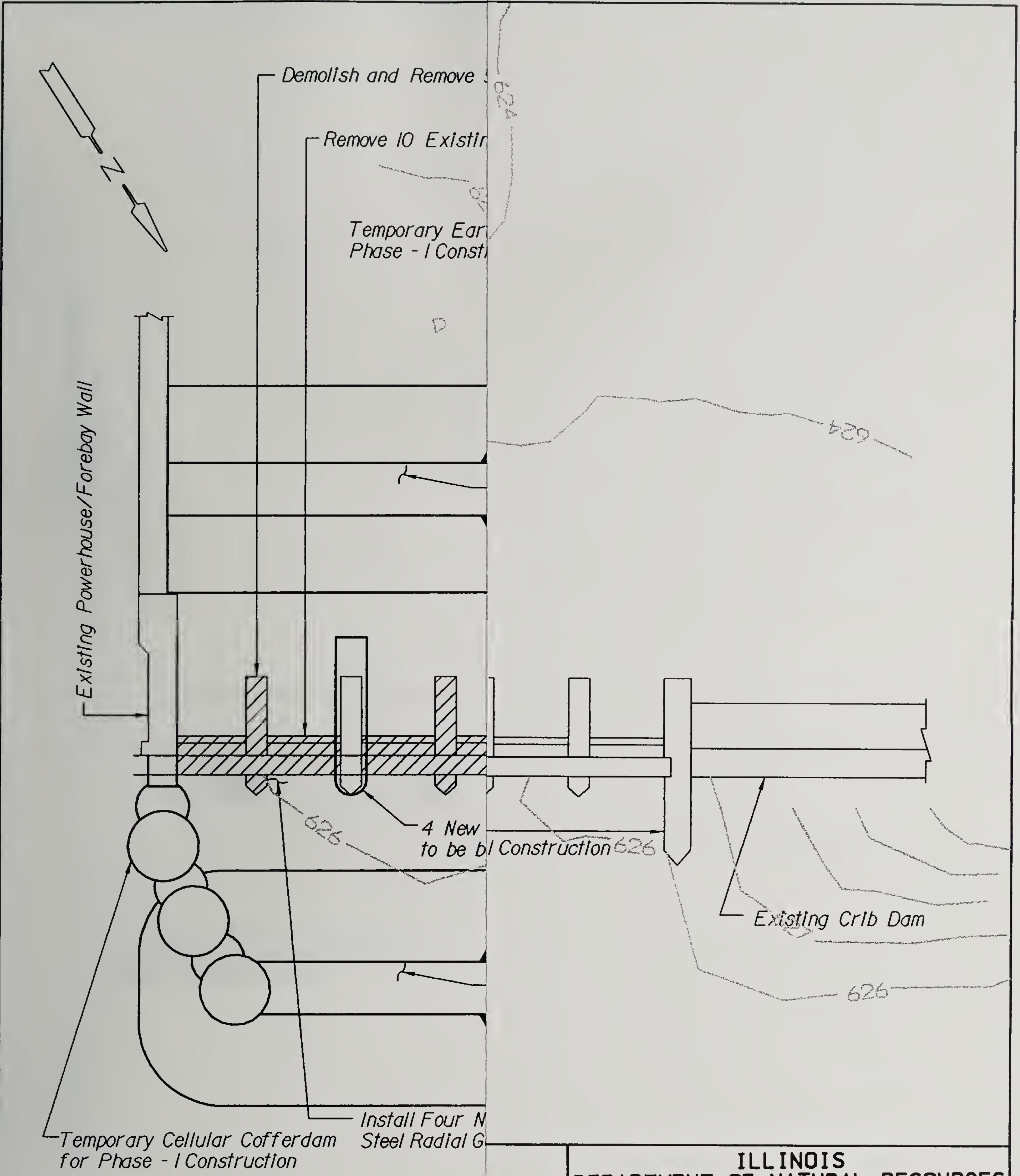
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 16

07/13/94 PRH

1731007A



ERS, INC.

ST.

0606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 4: HYBRID OF STEEL
RADIAL GATES AND RUBBER DAM

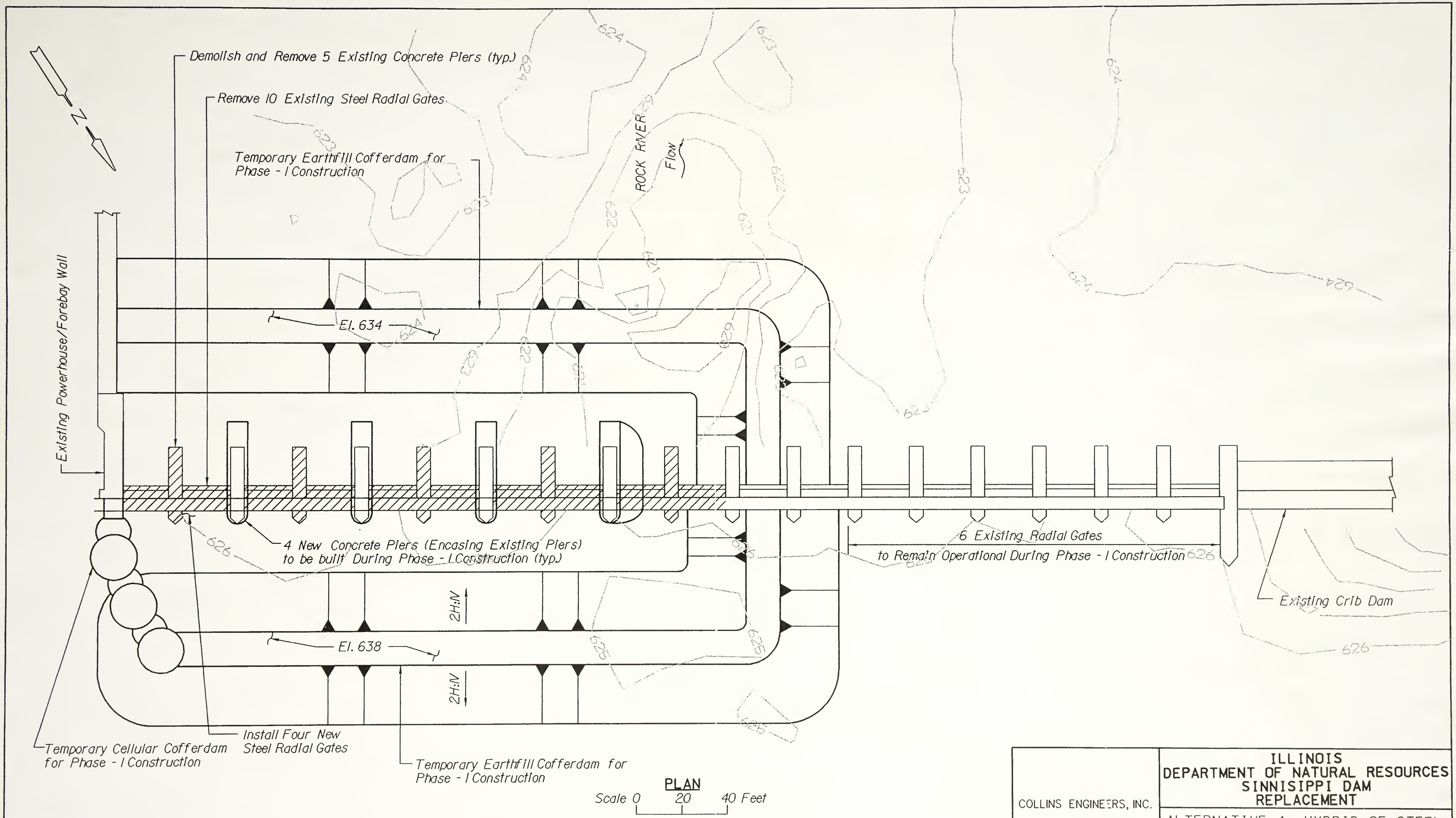
PHASE - I CONSTRUCTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 17

07/13/94 PRH

1310008A


N
Demolish and Remove 5 Existing Concrete Piers (typ.)
Remove 10 Existing Steel Radial Gates
Temporary Earthfill Cofferdam for Phase - I Construction
ROCK RIVER
Flow
Existing Powerhouse/Forebay Wall
El. 634
4 New Concrete Piers (Encasing Existing Piers) to be built During Phase - I Construction (typ.)
6 Existing Radial Gates to Remain Operational During Phase - I Construction
Existing Crib Dam
2H:1V
El. 638
2H:1V
Temporary Cellular Cofferdam for Phase - I Construction
Install Four New Steel Radial Gates
Temporary Earthfill Cofferdam for Phase - I Construction
624
623
622
621
625
626
PLAN
Scale 0 20 40 Feet

COLLINS ENGINEERS, INC.

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

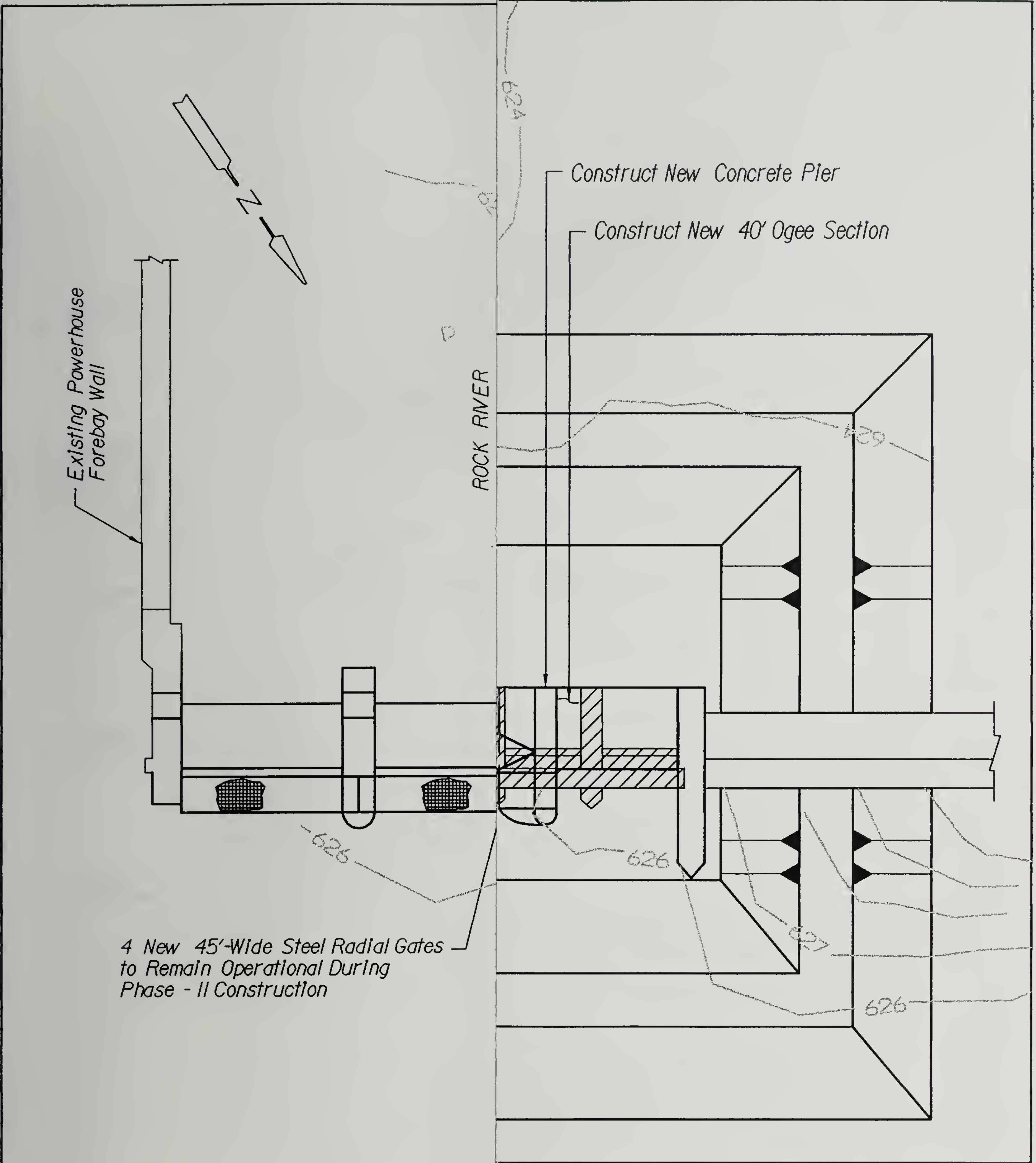
ALTERNATIVE 4: HYBRID OF STEEL
RADIAL GATES AND RUBBER DAM

PHASE - I CONSTRUCTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 17

07/13/94 PRH
131000BA



Construct New Concrete Pier
Construct New 40′ Ogee Section
N
Existing Powerhouse Forebay Wall
ROCK RIVER
624
626
627
4 New 45′-Wide Steel Radial Gates to Remain Operational During Phase - II Construction

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ILLINOIS
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SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 4: HYBRID OF STEEL RADIAL GATES AND RUBBER DAM

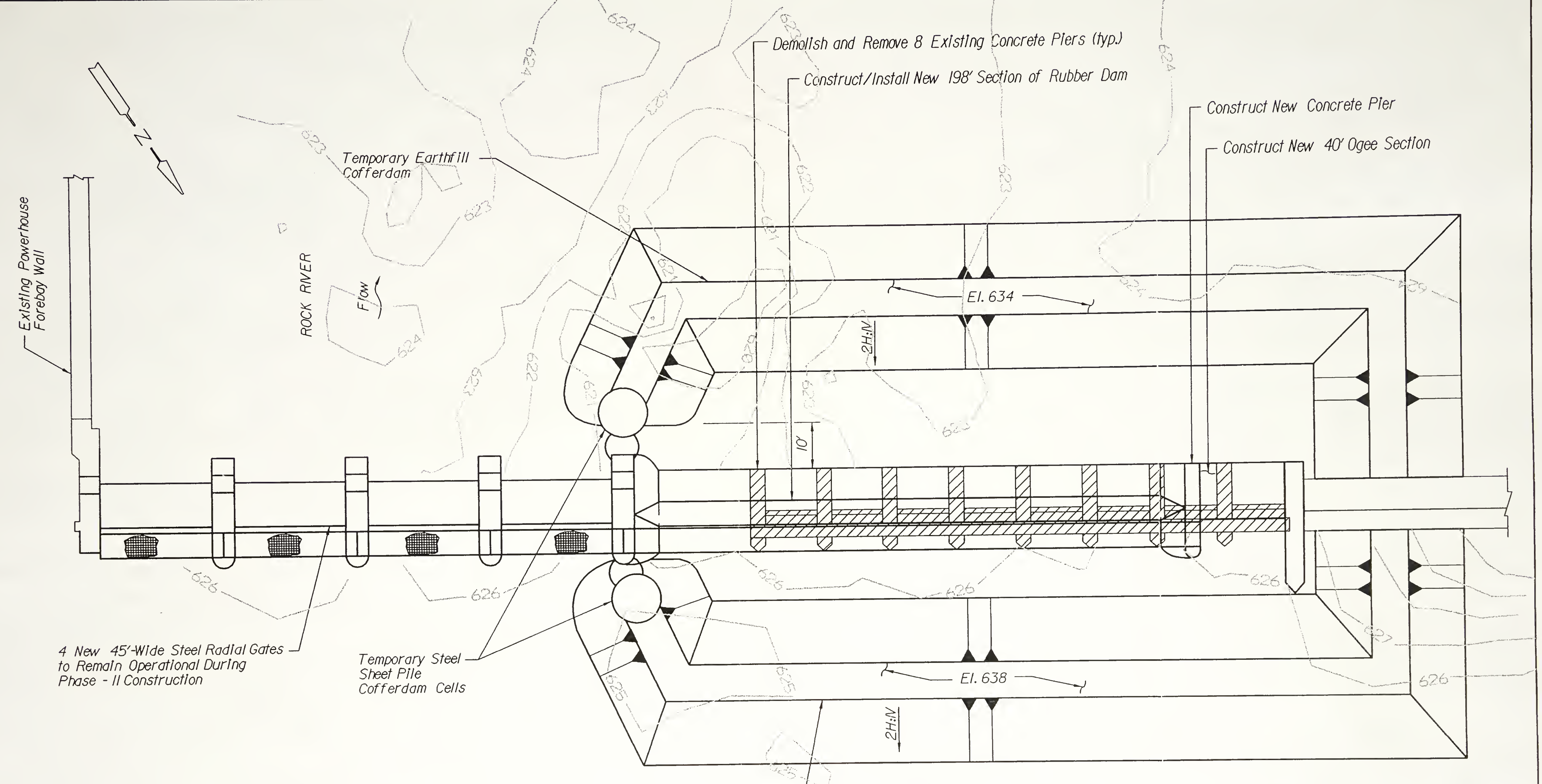
PHASE – II CONSTRUCTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 18

07/13/94 PRH

1731009A


N
Existing Powerhouse Forebay Wall
ROCK RIVER
Flow
Temporary Earthfill Cofferdam
Demolish and Remove 8 Existing Concrete Piers (typ.)
Construct/Install New 198' Section of Rubber Dam
Construct New Concrete Pier
Construct New 40' Ogee Section
El. 634
El. 638
2H:1V
10'
4 New 45'-Wide Steel Radial Gates to Remain Operational During Phase - II Construction
Temporary Steel Sheet Pile Cofferdam Cells
Temporary Earthfill Cofferdam
621
622
623
624
625
626
627

PLAN

Scale 0 20 40 Feet

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 4: HYBRID OF STEEL
RADIAL GATES AND RUBBER DAM

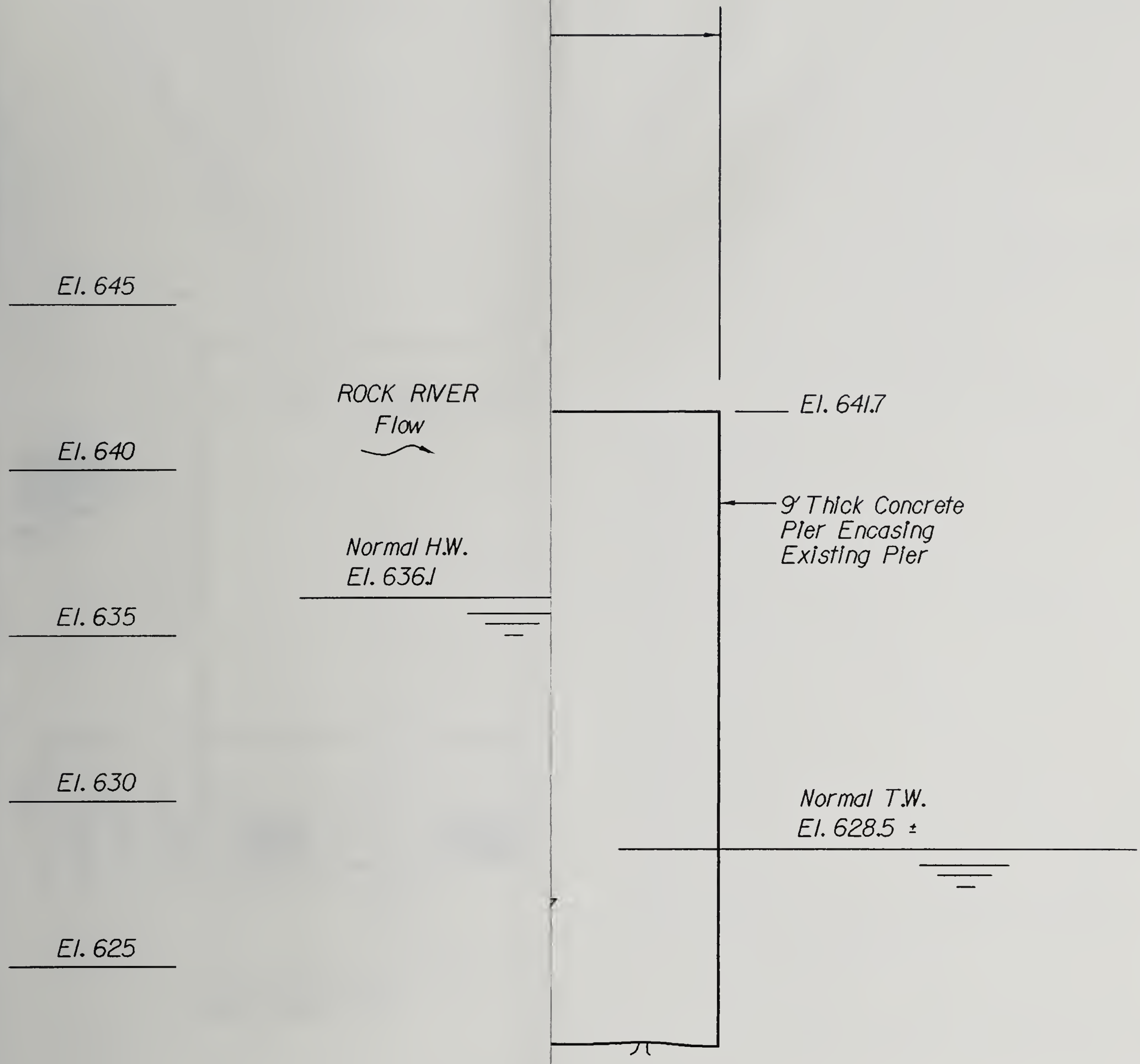
PHASE - II CONSTRUCTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 18

07/13/94 PRH

1731009A



ERS, INC.
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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 4: HYBRID OF STEEL RADIAL GATES AND RUBBER DAM

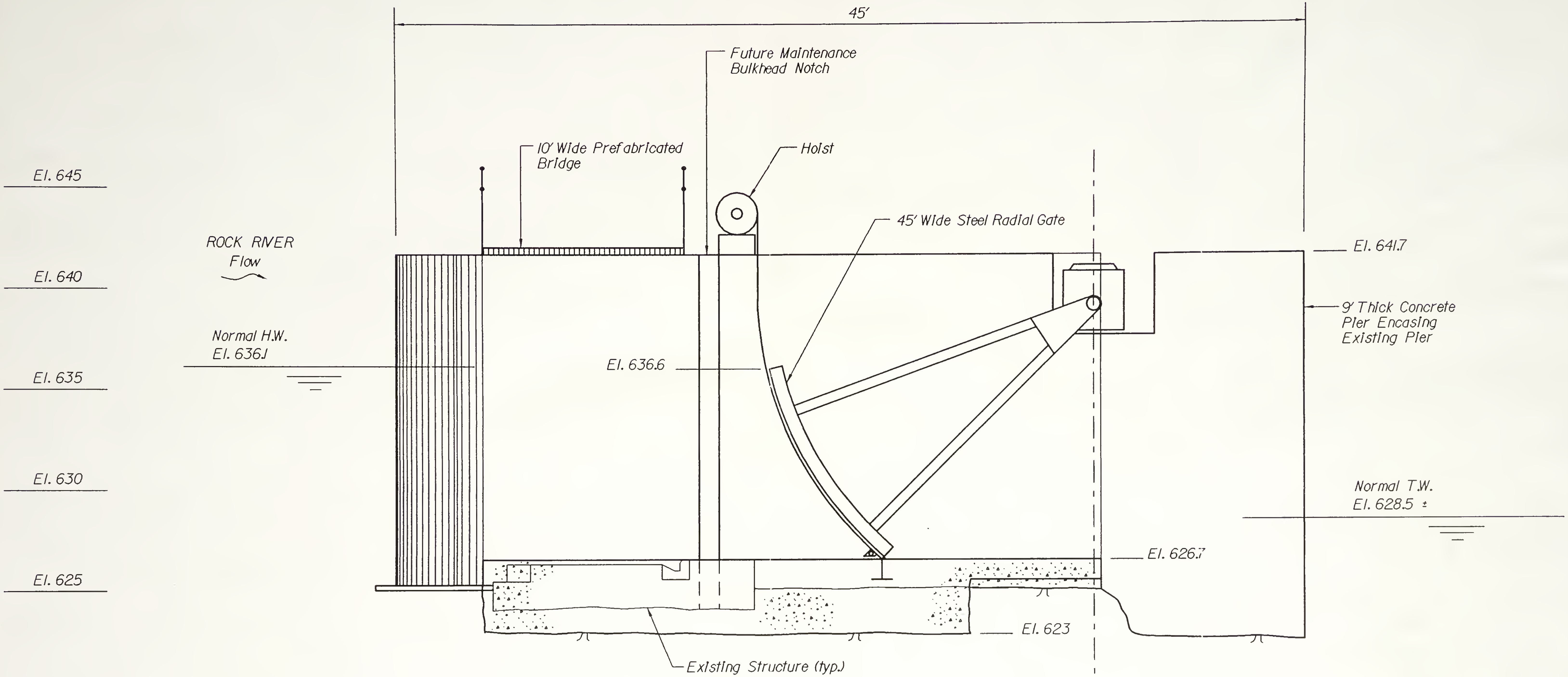
RADIAL GATE CROSS SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 19

07/13/94 PRH

1731013A


45'
Future Maintenance Bulkhead Notch
10' Wide Prefabricated Bridge
Hoist
45' Wide Steel Radial Gate
El. 645
El. 640
El. 635
El. 630
El. 625
ROCK RIVER Flow
Normal H.W. El. 636.1
El. 636.6
El. 641.7
9' Thick Concrete Pier Encasing Existing Pier
Normal T.W. El. 628.5 ±
El. 626.7
El. 623
Existing Structure (typ.)

CROSS SECTION

Scale 0 2.5 5 Feet

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ILLINOIS
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SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 4: HYBRID OF STEEL
RADIAL GATES AND RUBBER DAM

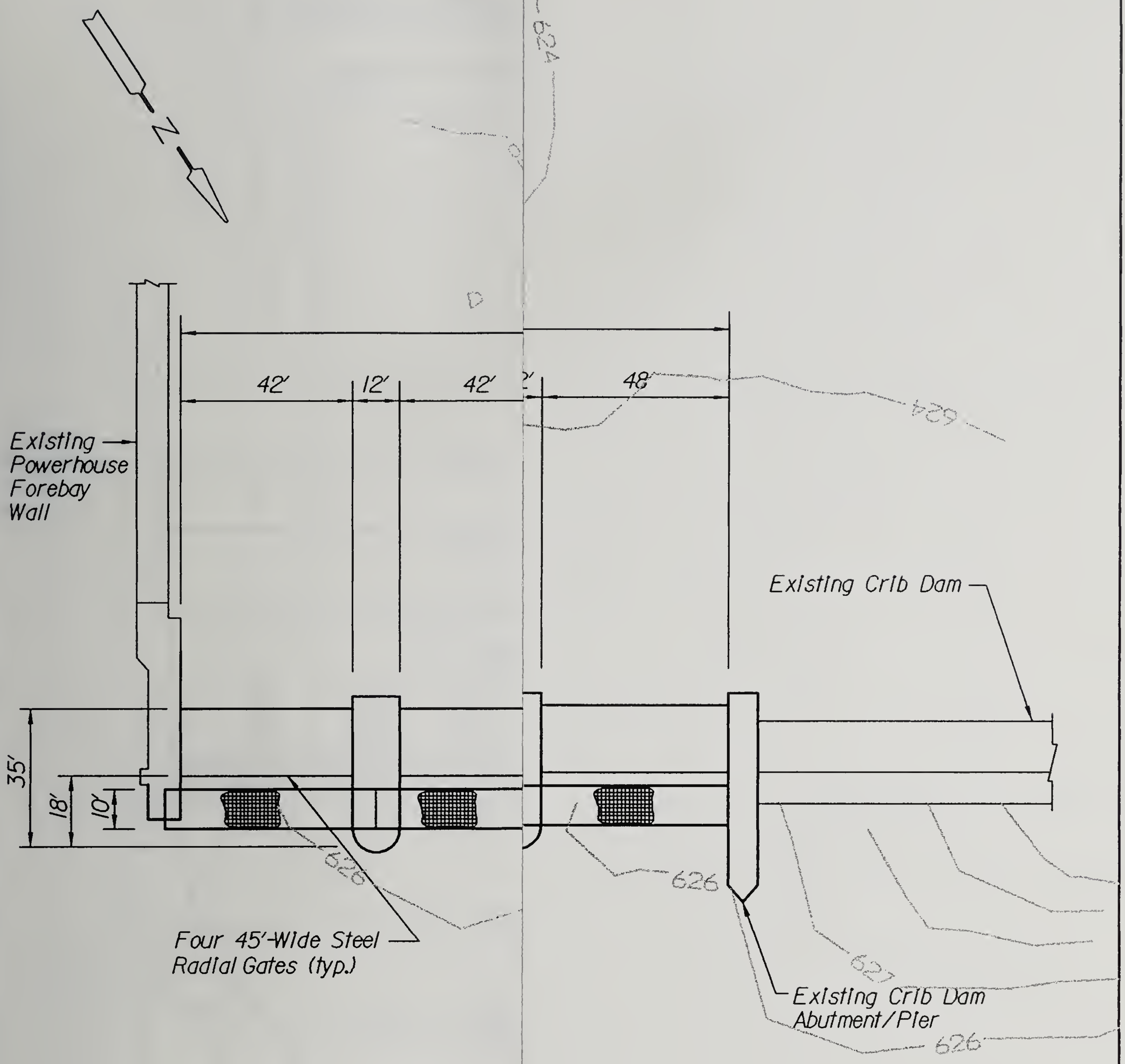
RADIAL GATE CROSS SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 19

07/13/94 PRH

1731013A


N
Existing Powerhouse Forebay Wall
42′
12′
42′
2′
48′
624
624
35′
18′
10′
Existing Crib Dam
626
626
627
626
Four 45′-Wide Steel Radial Gates (typ.)
Existing Crib Dam Abutment/Pier

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ILLINOIS
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SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 5: STEEL RADIAL GATES

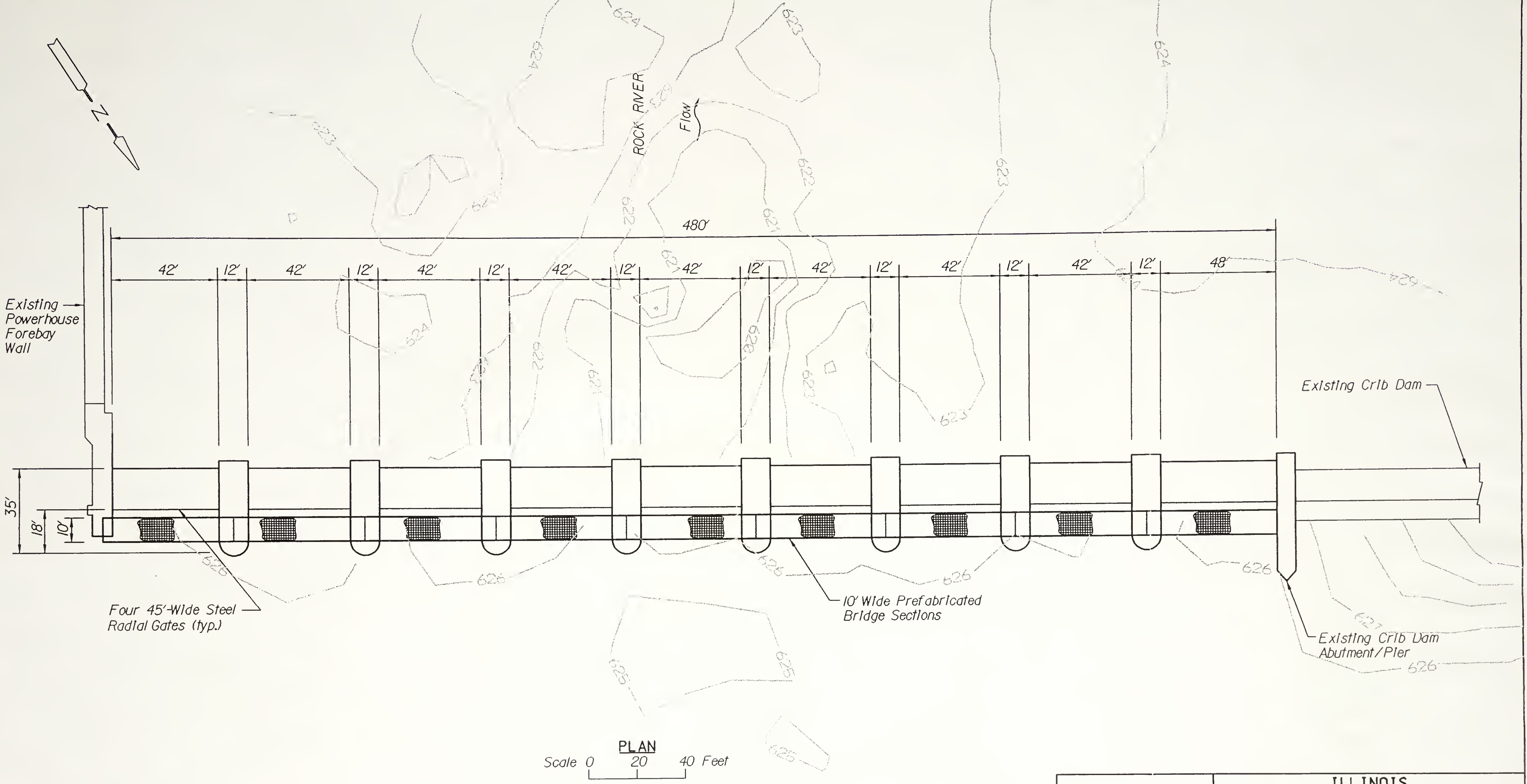
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 20

07/13/94 PRH

1731020A


N
ROCK RIVER
Flow
624
623
622
621
620
625
626
627
480'
42'
12'
48'
35'
18'
10'
Existing Powerhouse Forebay Wall
Existing Crib Dam
Existing Crib Dam Abutment/Pier
Four 45'-Wide Steel Radial Gates (typ.)
10' Wide Prefabricated Bridge Sections
PLAN
Scale 0 20 40 Feet

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 5: STEEL RADIAL GATES

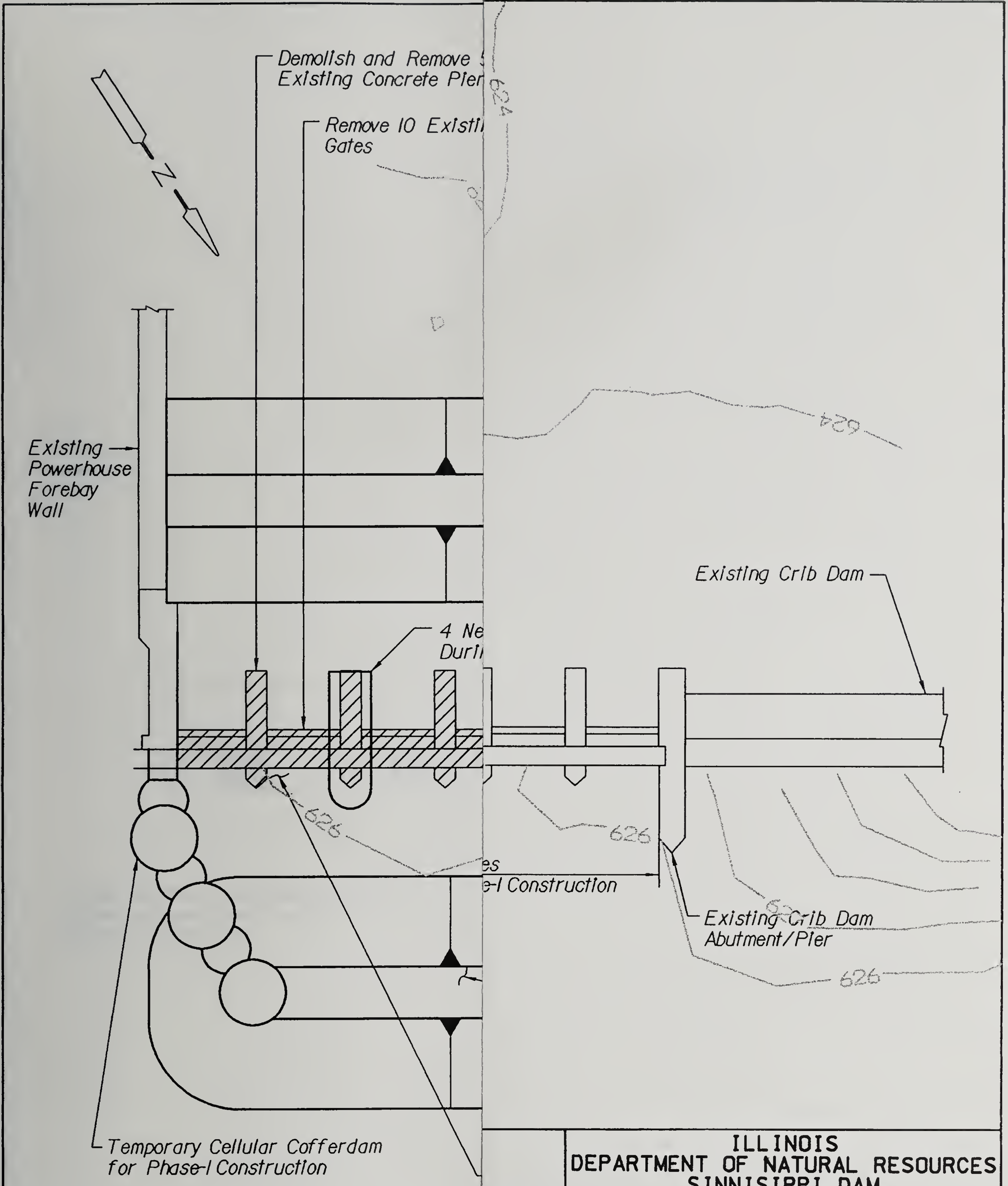
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 20

07/13/94 PRH

1731020A



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ILLINOIS
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SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 5: STEEL RADIAL GATES

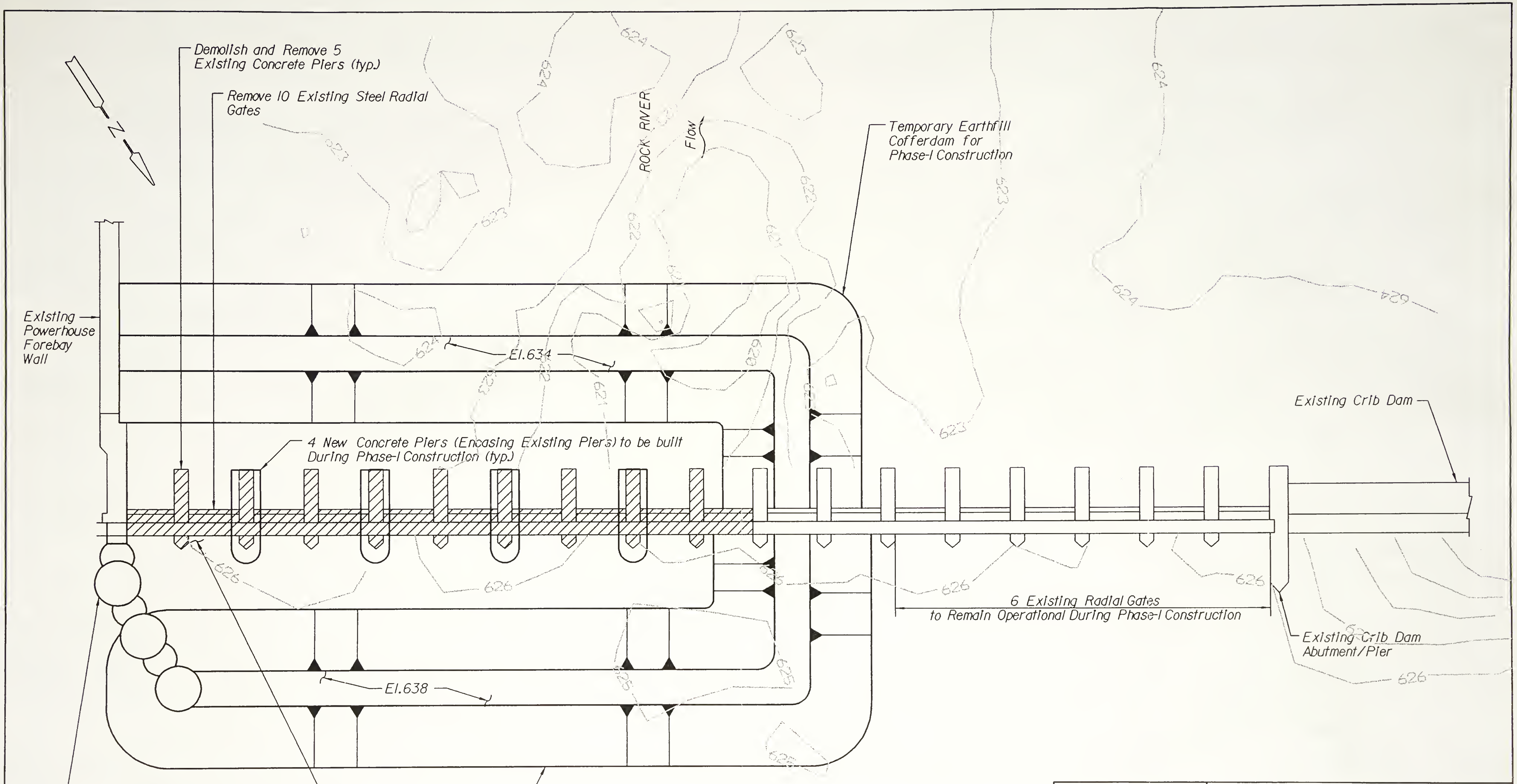
PHASE -I CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 21

07/13/94 PRH

1731022A


N
Demolish and Remove 5 Existing Concrete Piers (typ.)
Remove 10 Existing Steel Radial Gates
ROCK RIVER
Flow
Temporary Earthfill Cofferdam for Phase-I Construction
Existing Powerhouse Forebay Wall
El. 634
Existing Crib Dam
4 New Concrete Piers (Encasing Existing Piers) to be built During Phase-I Construction (typ.)
6 Existing Radial Gates to Remain Operational During Phase-I Construction
Existing Crib Dam Abutment/Pier
El. 638
Temporary Cellular Cofferdam for Phase-I Construction
Install Four New Steel Radial Gates
Temporary Earthfill Cofferdam for Phase-I Construction
PLAN
Scale 0 20 40 Feet
621
622
623
624
625
626
629

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ILLINOIS
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SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 5: STEEL RADIAL GATES

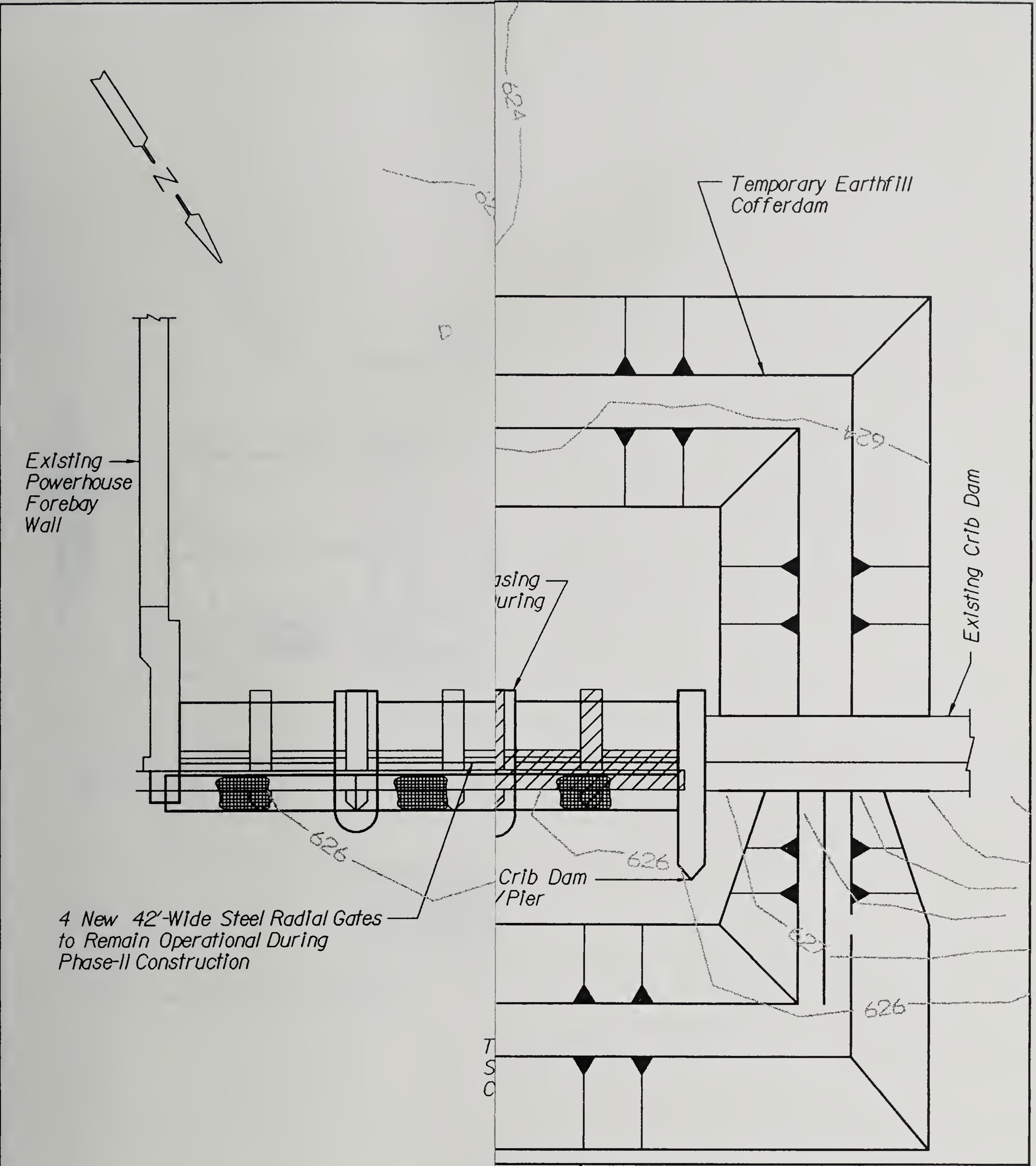
PHASE -I CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 21

07/13/94 PRH

1731022A


N
624
62
Temporary Earthfill Cofferdam
629
Existing Crib Dam
Existing Powerhouse Forebay Wall
asing
uring
626
Crib Dam
/Pier
627
626
4 New 42'-Wide Steel Radial Gates to Remain Operational During Phase-II Construction
T
S
C

ERS, INC.

L ST.

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 5: STEEL RADIAL GATES

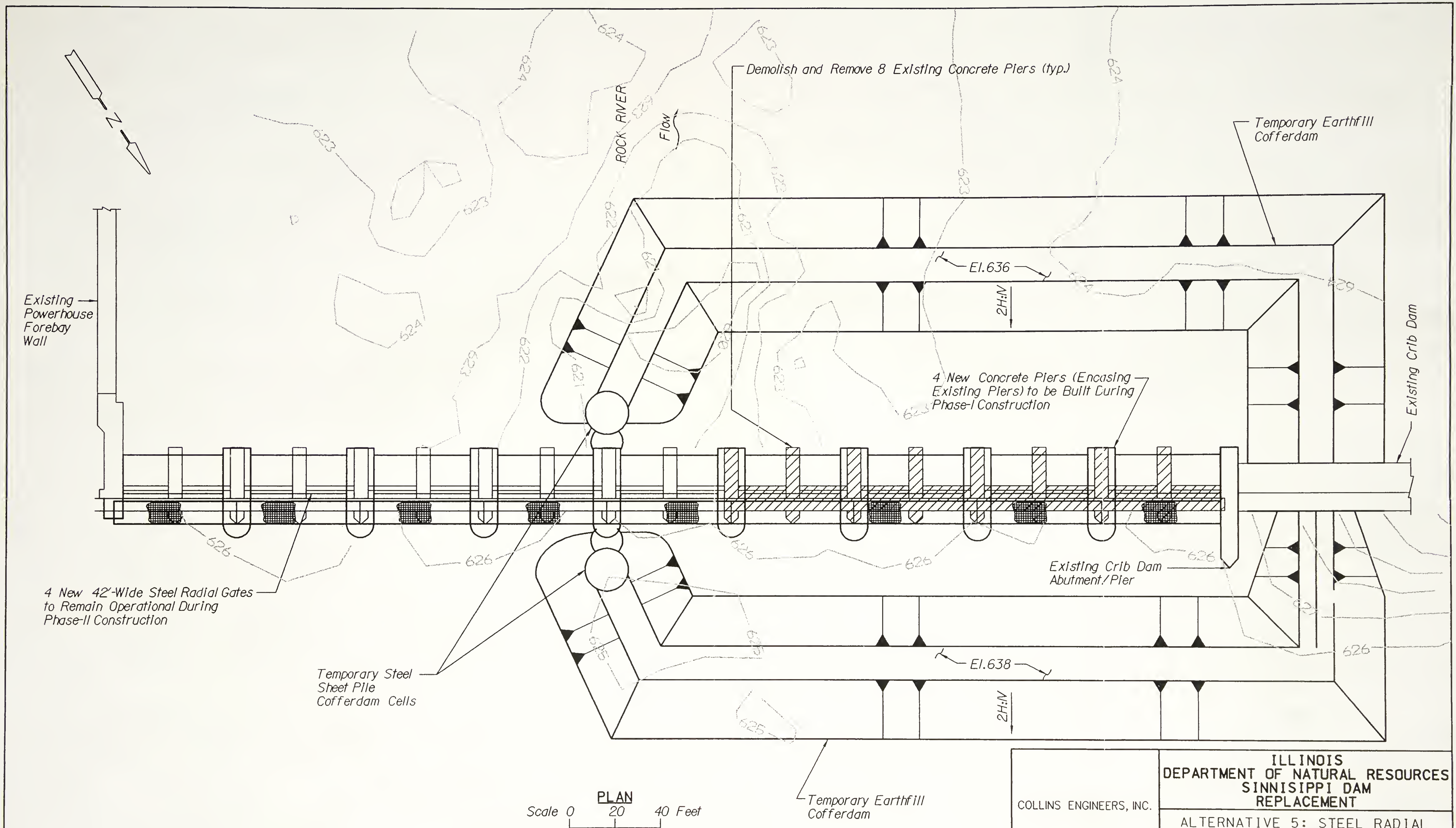
PHASE-II CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 22

07/13/94 PRH

1731021A


N
ROCK RIVER
Flow
Demolish and Remove 8 Existing Concrete Piers (typ.)
Temporary Earthfill Cofferdam
Existing Powerhouse Forebay Wall
El.636
2H:V
Existing Crib Dam
4 New Concrete Piers (Encasing Existing Piers) to be Built During Phase-I Construction
Existing Crib Dam Abutment/Pier
4 New 42'-Wide Steel Radial Gates to Remain Operational During Phase-II Construction
Temporary Steel Sheet Pile Cofferdam Cells
El.638
2H:V
Temporary Earthfill Cofferdam
624
623
622
621
626
625
PLAN
Scale 0 20 40 Feet

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CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

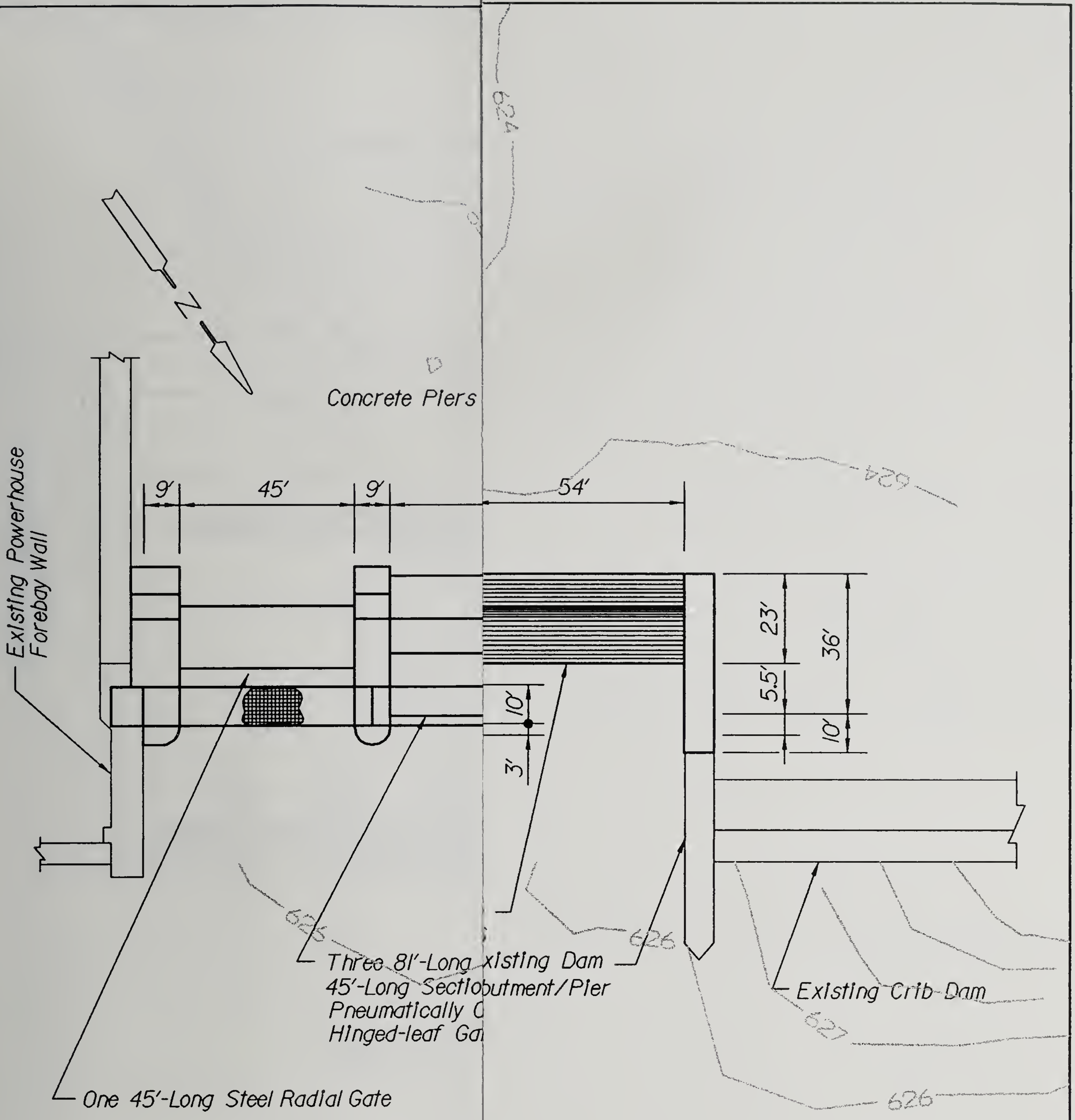
ALTERNATIVE 5: STEEL RADIAL GATES

PHASE-II CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 22

07/13/94 PRH
1731021A


624
Concrete Piers
N
Existing Powerhouse Forebay Wall
9'
45'
9'
54'
624
23'
36'
5.5'
10'
10'
3'
626
626
627
626
Three 81'-Long Existing Dam
45'-Long Sectio butment/Pier
Pneumatically C
Hinged-leaf Ga
Existing Crib Dam
One 45'-Long Steel Radial Gate

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

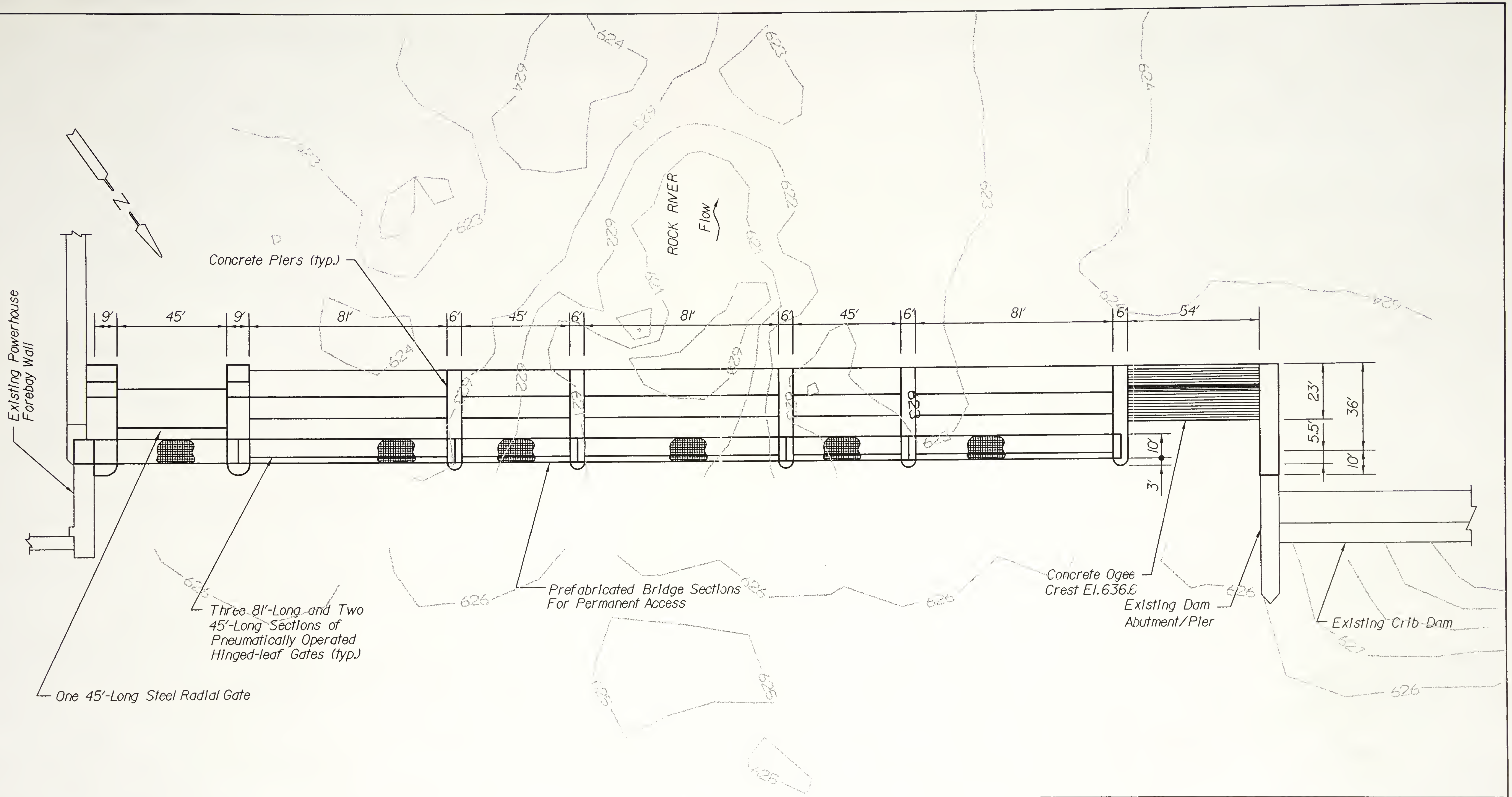
ALTERNATIVE 6: HYBRID OF PNEUMATICALLY
OPERATED HINGED-LEAF GATES AND
ONE RADIAL GATE
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: OCTOBER, 1994 FIG. Prelim. 23

09/28/94 PRH

1731025A


Existing Powerhouse Forebay Wall
Concrete Piers (typ.)
ROCK RIVER
Flow
9'
45'
9'
81'
6'
45'
6'
81'
6'
45'
6'
81'
6'
54'
23'
36'
5.5'
10'
10'
10'
3'
623
624
622
621
625
626
627
Three 81'-Long and Two 45'-Long Sections of Pneumatically Operated Hinged-leaf Gates (typ.)
One 45'-Long Steel Radial Gate
Prefabricated Bridge Sections For Permanent Access
Concrete Ogee Crest El.636.6
Existing Dam Abutment/Pier
Existing Crib Dam
N

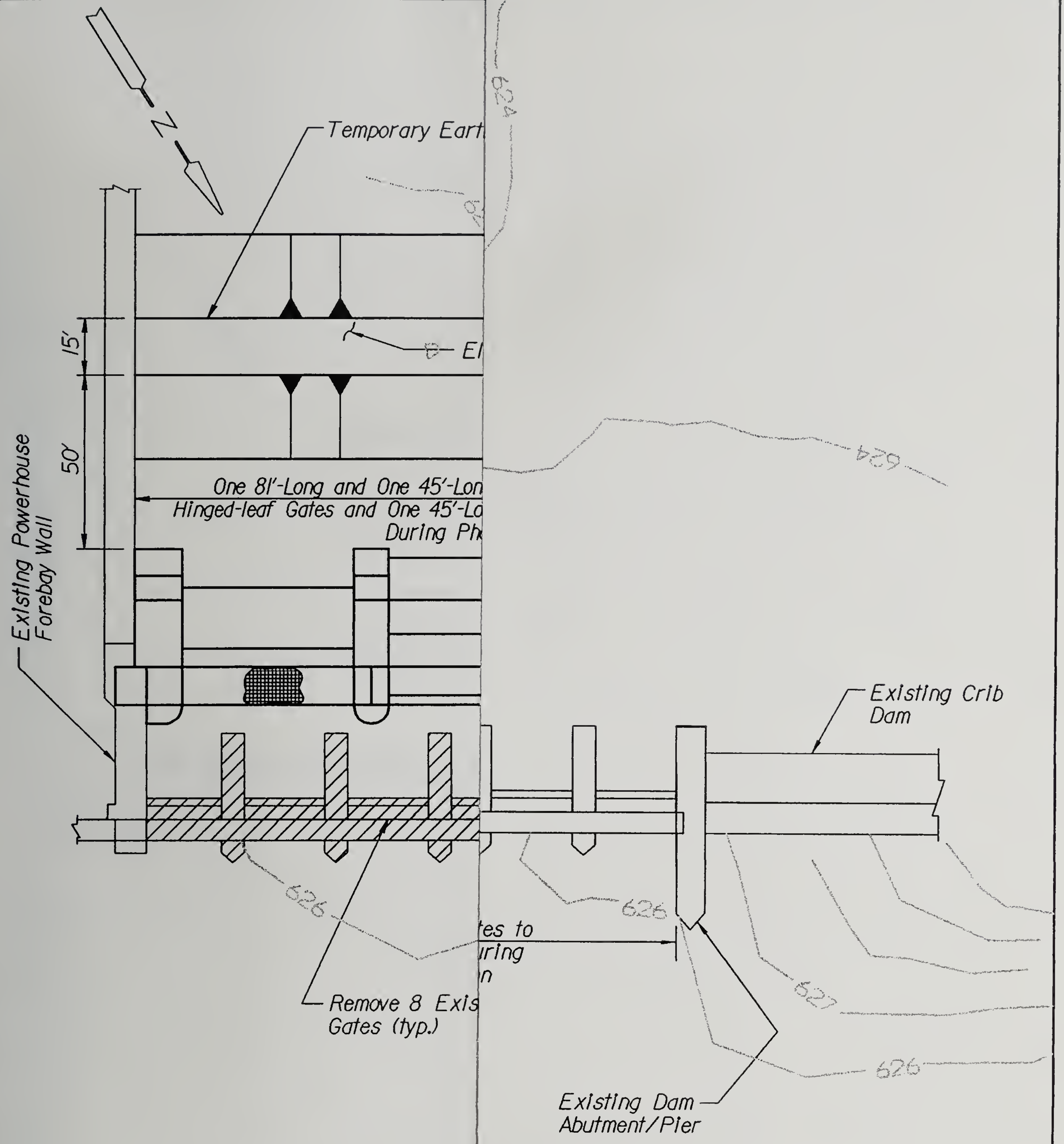
PLAN

Scale 0 20 40 Feet

COLLINS ENGINEERS, INC. 165 N. CANAL ST. CHICAGO, IL. 60606	ILLINOIS DEPARTMENT OF NATURAL RESOURCES SINNISIPPI DAM REPLACEMENT
	ALTERNATIVE 6: HYBRID OF PNEUMATICALLY OPERATED HINGED-LEAF GATES AND ONE RADIAL GATE PLAN
	DRAWN BY: PRH CHECKED BY: QF
	DATE: OCTOBER, 1994 FIG. Prelim. 23

09/28/94 PRH

1731025A


N
Temporary Eart
624
62
El
15'
50'
Existing Powerhouse Forebay Wall
One 81'-Long and One 45'-Lon
Hinged-leaf Gates and One 45'-Lo
During Ph
624
Existing Crib Dam
626
626
tes to
uring
n
Remove 8 Exis
Gates (typ.)
627
626
Existing Dam Abutment/Pier

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L ST.

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 6: HYBRID OF PNEUMATICALLY
OPERATED HINGED-LEAF GATES AND
ONE RADIAL GATE

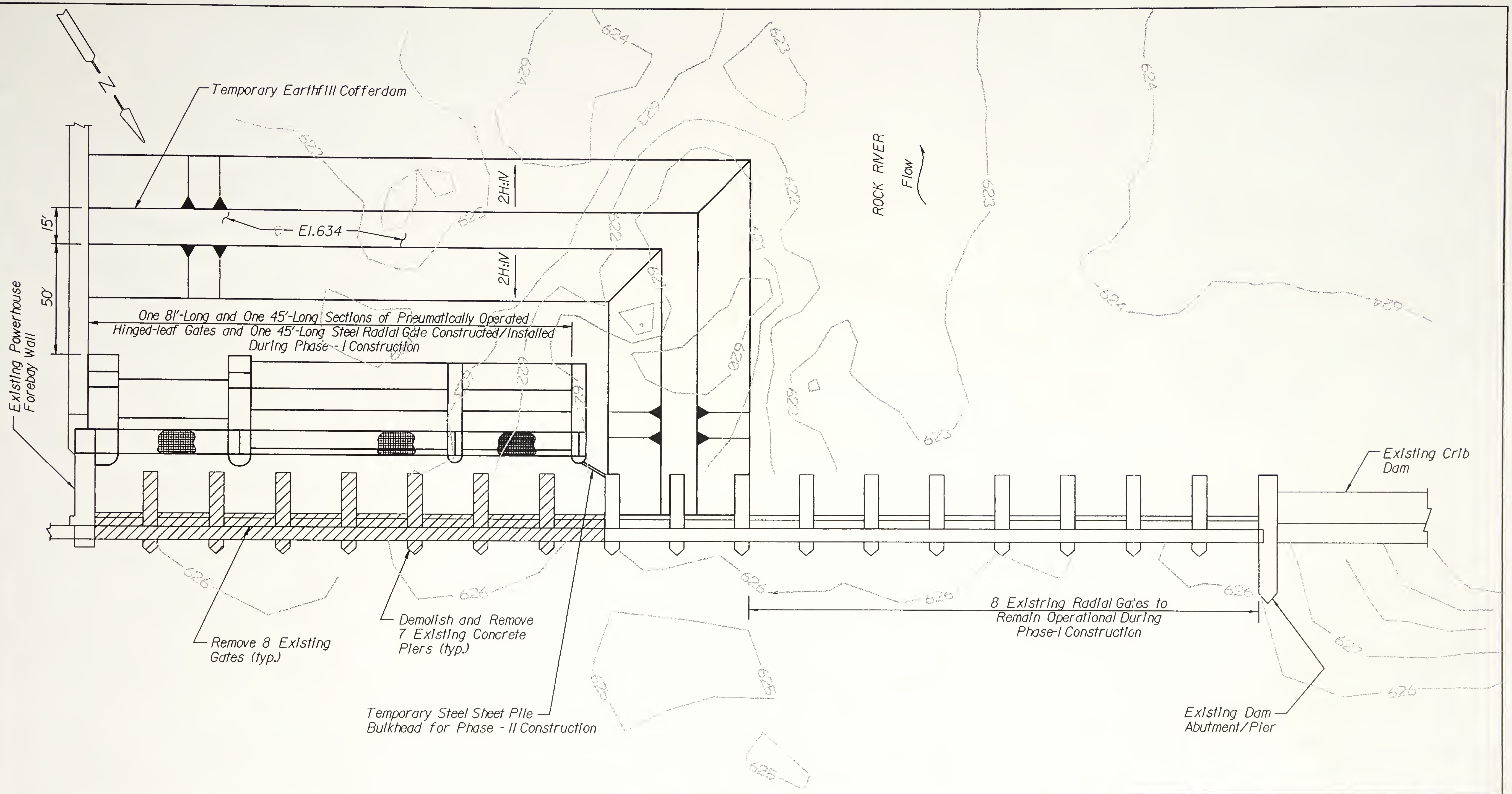
PHASE-I CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 24

07/13/94 PRH

1731026A


N
Temporary Earthfill Cofferdam
15'
50'
El.634
2H:1V
2H:1V
One 81'-Long and One 45'-Long Sections of Pneumatically Operated
Hinged-leaf Gates and One 45'-Long Steel Radial Gate Constructed/Installed
During Phase - I Construction
Existing Powerhouse Forebay Wall
ROCK RIVER
Flow
624
623
622
621
620
625
626
Existing Crib Dam
Remove 8 Existing Gates (typ.)
Demolish and Remove 7 Existing Concrete Piers (typ.)
Temporary Steel Sheet Pile Bulkhead for Phase - II Construction
8 Existring Radial Gates to Remain Operational During Phase-I Construction
Existing Dam Abutment/Pier

PLAN

Scale 0 20 40 Feet

COLLINS ENGINEERS, INC.

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CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 6: HYBRID OF PNEUMATICALLY OPERATED HINGED-LEAF GATES AND ONE RADIAL GATE

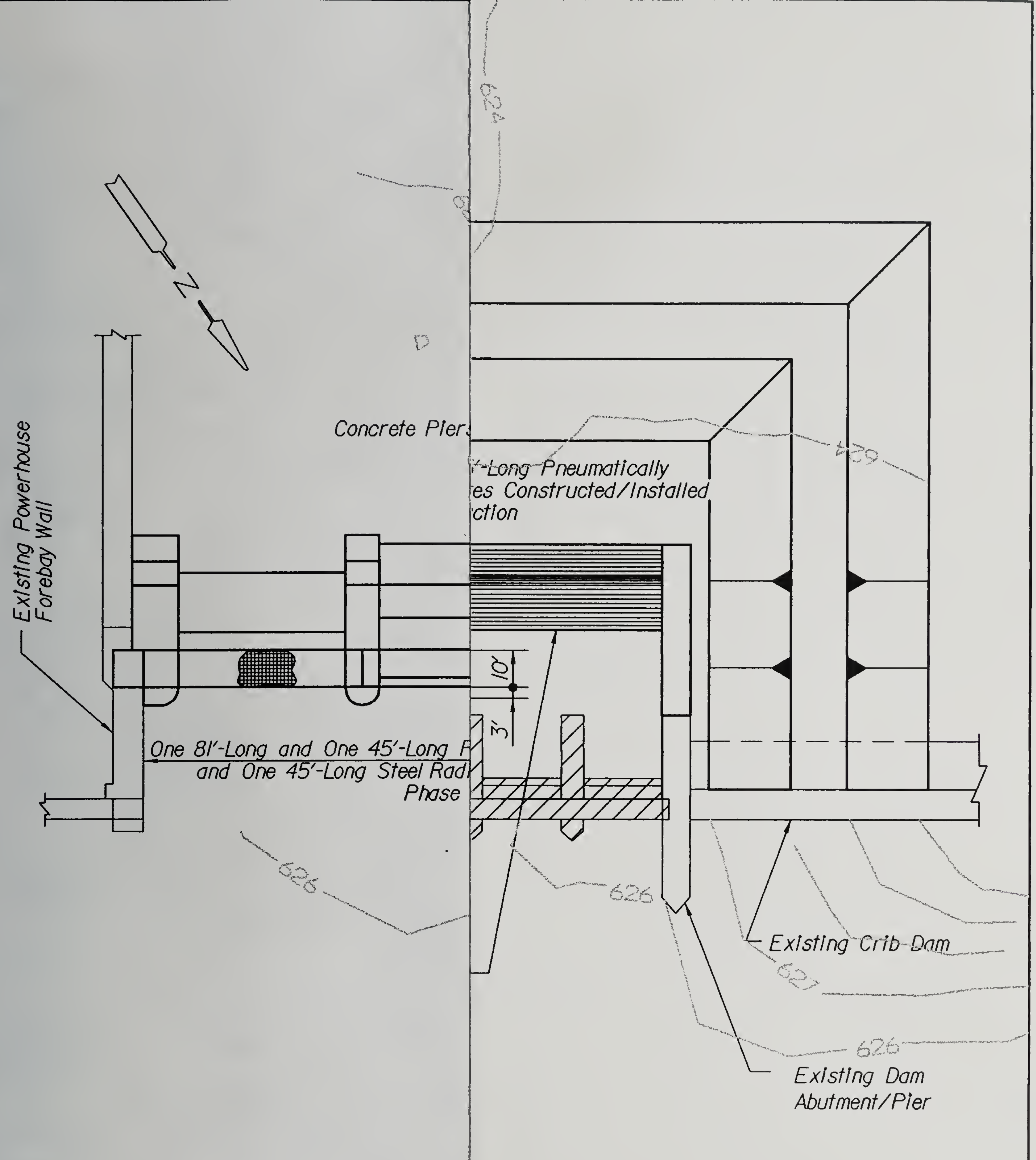
PHASE-I CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 24

07/13/94 PRH

1731026A



N
624
624
D
Concrete Pier
'-Long Pneumatically
es Constructed/Installed
ction
Existing Powerhouse Forebay Wall
10'
3'
One 81'-Long and One 45'-Long P
and One 45'-Long Steel Rad
Phase
626
626
Existing Crib Dam
627
626
Existing Dam Abutment/Pier

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L ST.

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 6: HYBRID OF PNEUMATICALLY OPERATED HINGED-LEAF GATES AND ONE RADIAL GATE

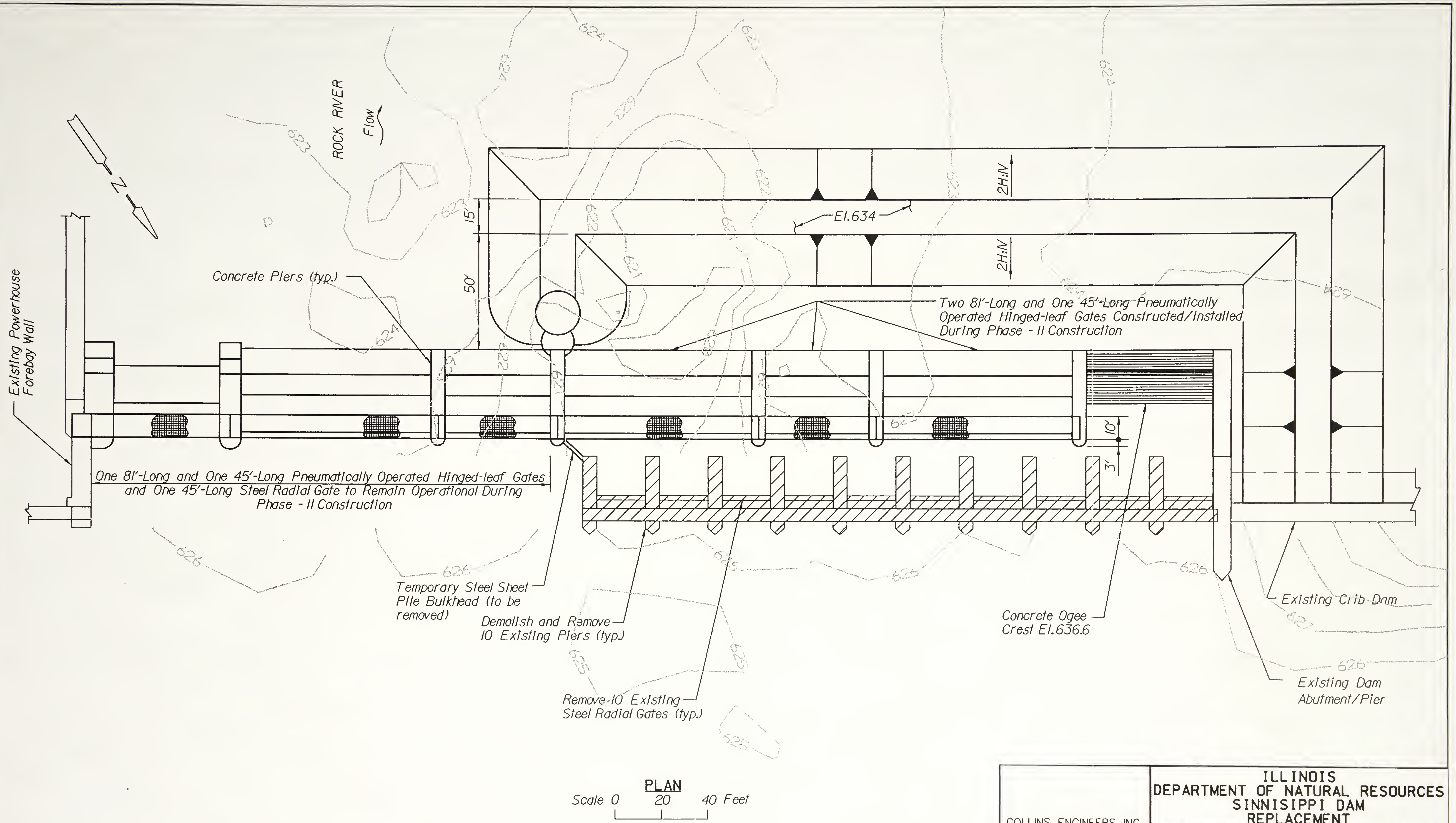
PHASE – II CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: OCTOBER, 1994 FIG. Prelim. 25

09/28/94 PRH

1731027A


ROCK RIVER
Flow
N
Existing Powerhouse Forebay Wall
Concrete Piers (typ.)
15'
50'
El.634
2H:1V
2H:1V
Two 81'-Long and One 45'-Long Pneumatically Operated Hinged-leaf Gates Constructed/Installed During Phase - II Construction
10'
3'
One 81'-Long and One 45'-Long Pneumatically Operated Hinged-leaf Gates and One 45'-Long Steel Radial Gate to Remain Operational During Phase - II Construction
Temporary Steel Sheet Pile Bulkhead (to be removed)
Demolish and Remove 10 Existing Piers (typ.)
Remove 10 Existing Steel Radial Gates (typ.)
Concrete Ogee Crest El.636.6
Existing Crib Dam
Existing Dam Abutment/Pier
623
624
622
621
626
625
627
PLAN
Scale 0 20 40 Feet

COLLINS ENGINEERS, INC.

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CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 6: HYBRID OF PNEUMATICALLY OPERATED HINGED-LEAF GATES AND ONE RADIAL GATE

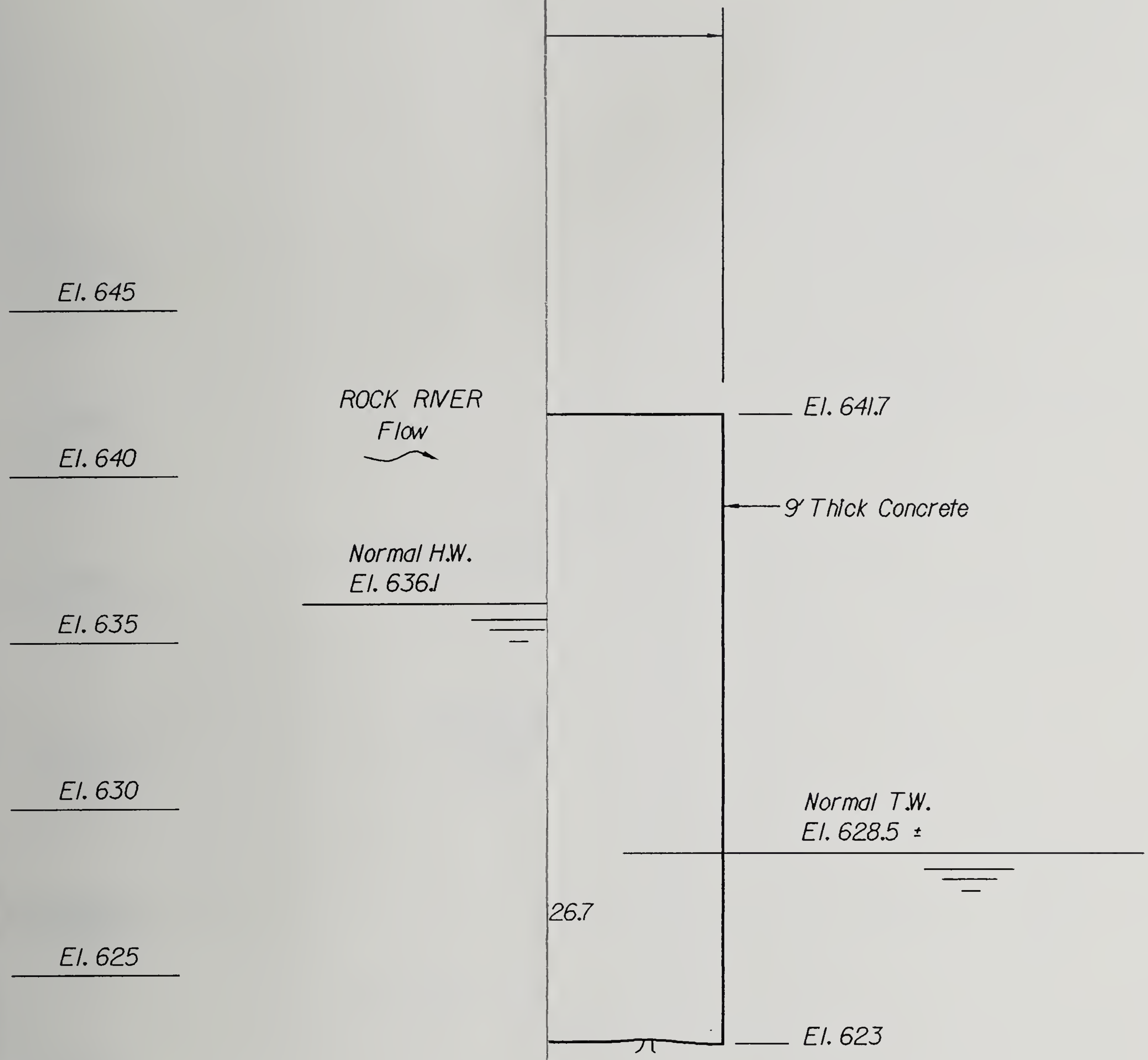
PHASE – II CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: OCTOBER, 1994 FIG. Prelim. 25

09/28/94 PRH

1731027A



EERS, INC.

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 6: HYBRID OF PNEUMATICALLY
OPERATED HINGED-LEAF GATES AND
ONE RADIAL GATE

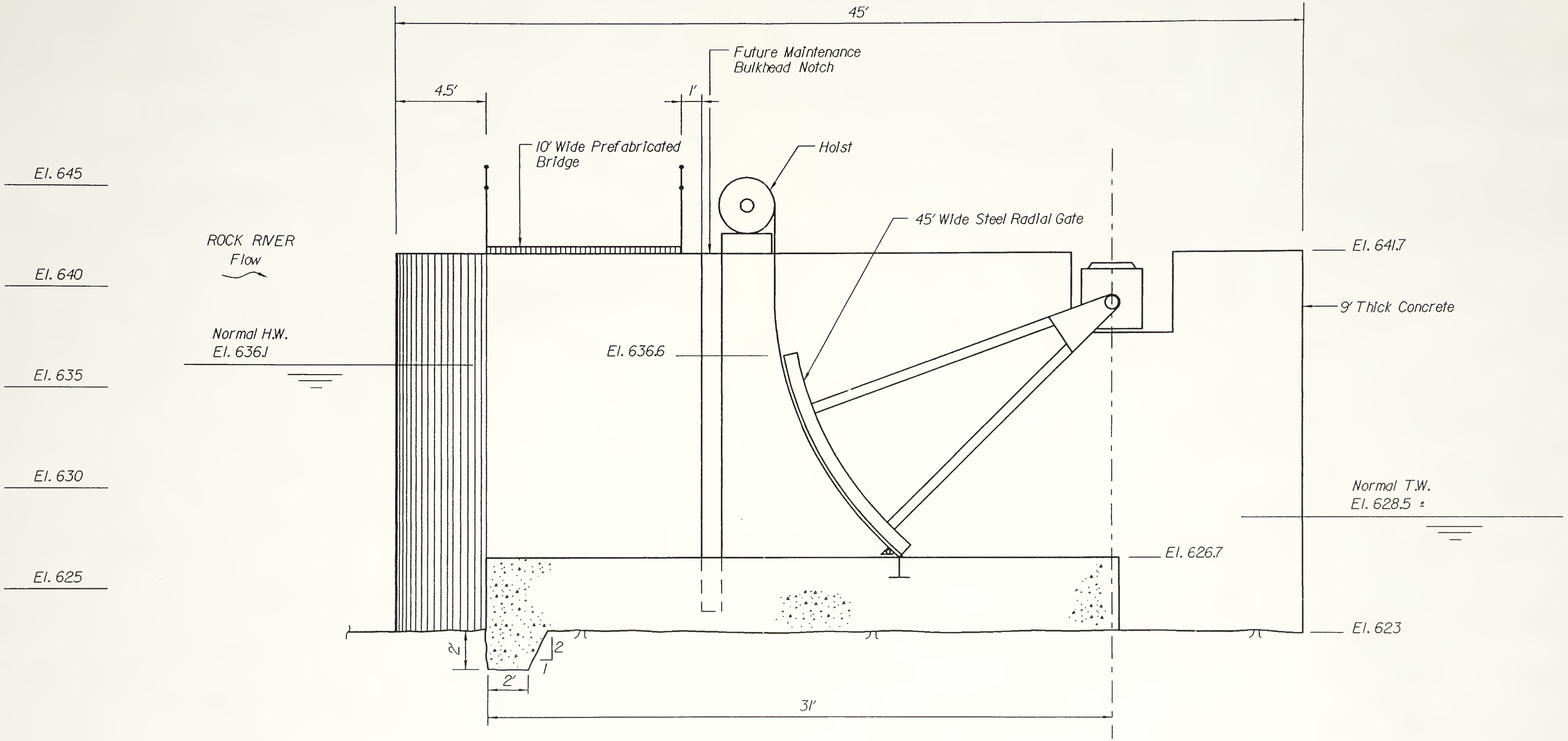
RADIAL GATE CROSS - SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: OCTOBER, 1994 FIG. Prelim. 26

09/29/94 PRH

1731028A



CROSS SECTION

Scale 0 2.5 5 Feet

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 6: HYBRID OF PNEUMATICALLY OPERATED HINGED-LEAF GATES AND ONE RADIAL GATE

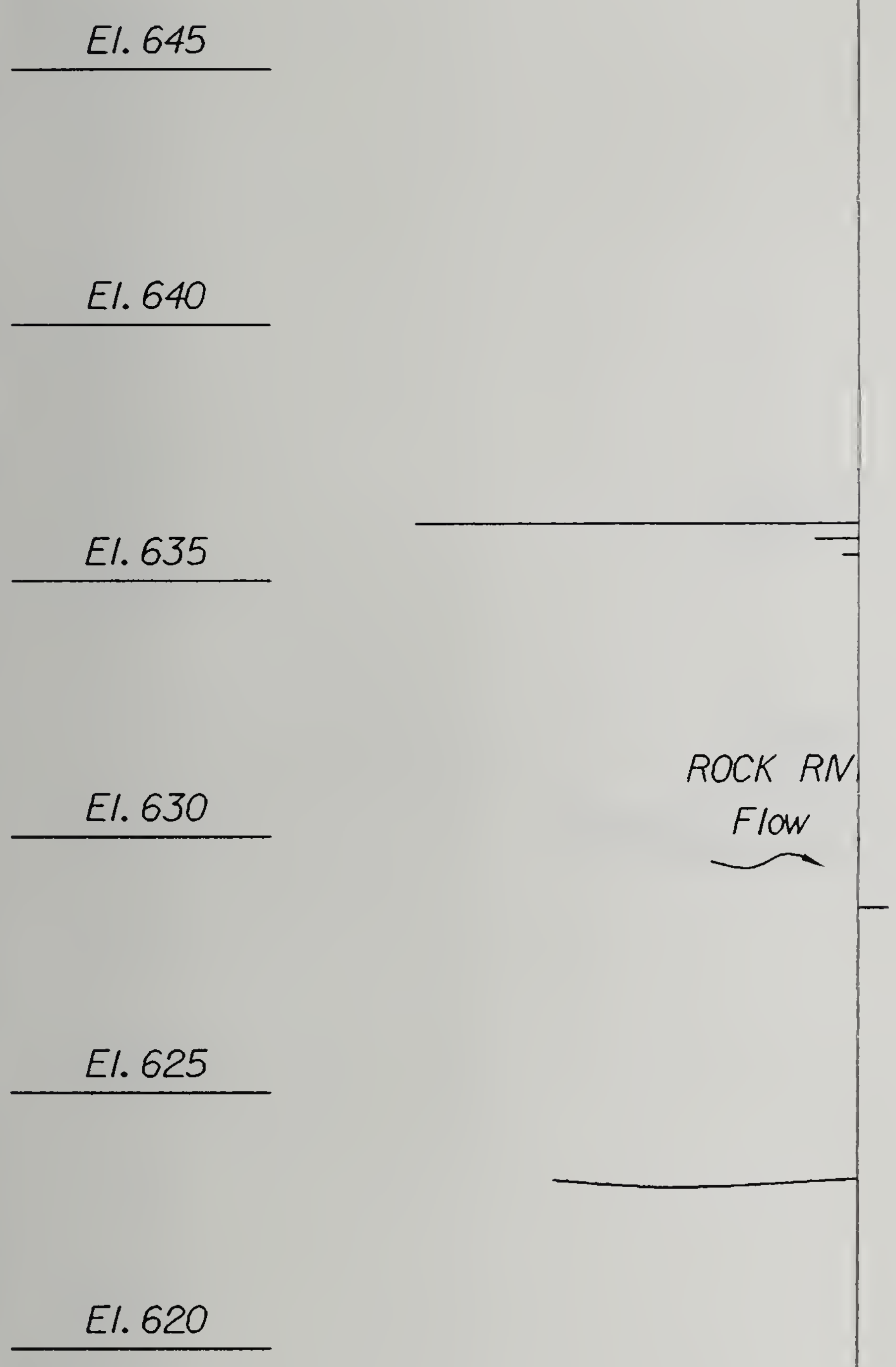
RADIAL GATE CROSS - SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: OCTOBER, 1994 FIG. Prelim. 26

09/29/94 PRH

1731028A



ERS, INC.

L ST.

60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 1, 2, 4 AND 6

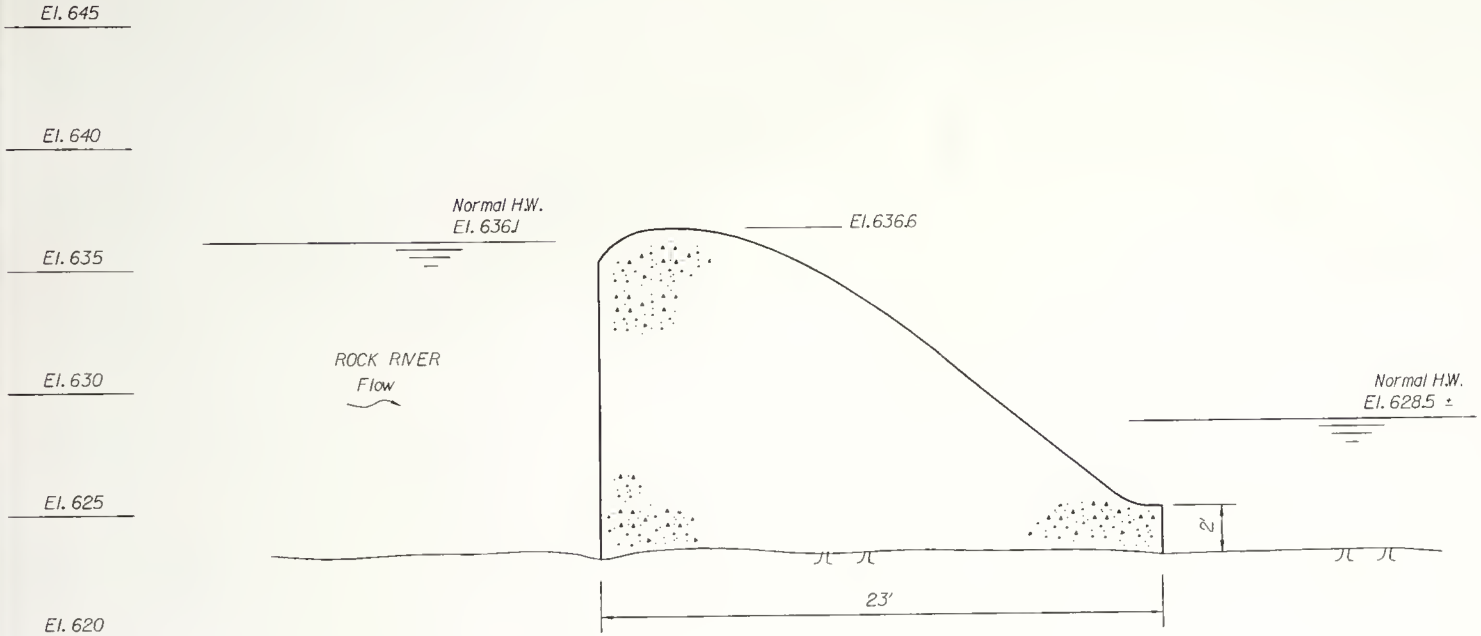
OGEE CROSS - SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1994 FIG. Prelim. 27

07/28/94 PRH

1731015A



CROSS SECTION

Scale 0 2.5 5 Feet

COLLINS ENGINEERS, INC.

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 1, 2, 4 AND 6

OGEE CROSS - SECTION

DRAWN BY: PRH CHECKED BY: QF

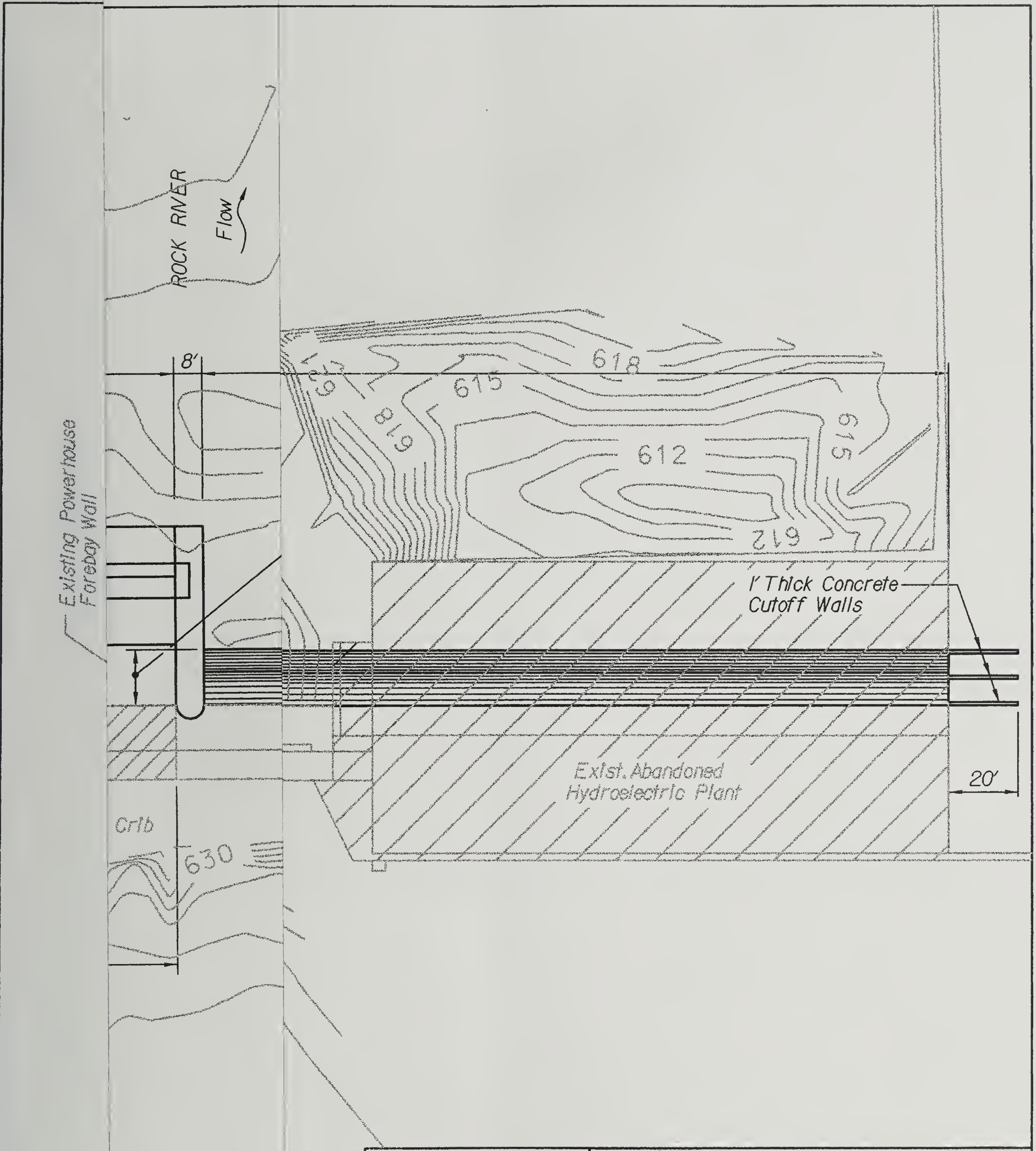
DATE: AUGUST, 1994 FIG. Prelim. 27

07/28/94 PRH

1731015A

SECTION 12

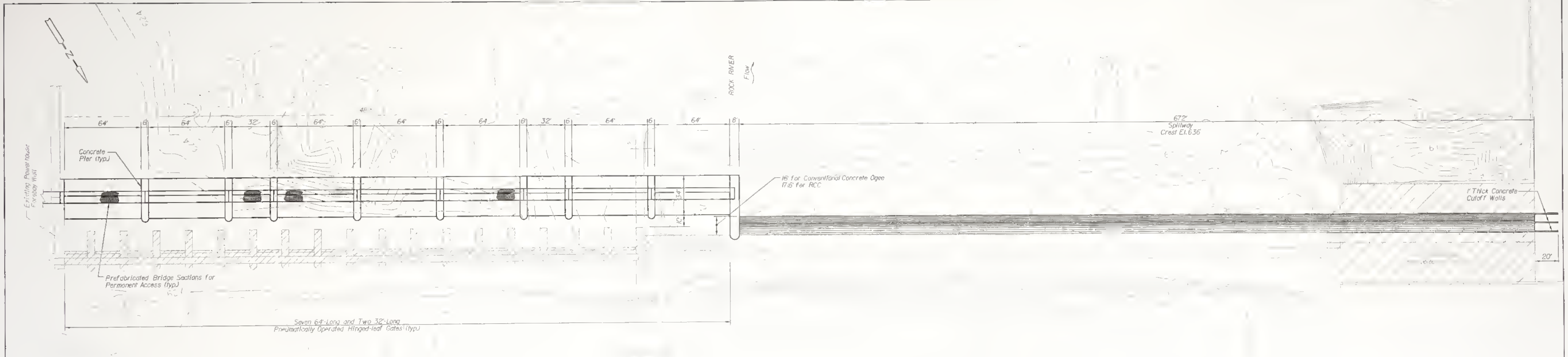
FIGURES,
FINAL ALTERNATIVES


ROCK RIVER
Flow
8'
Existing Powerhouse Forebay Wall
618
615
618
615
612
612
615
1' Thick Concrete Cutoff Walls
Exist. Abandoned Hydroelectric Plant
20'
Crib
630
PLA
Scale 0
20

COLLINS ENGINEERS, INC. 165 N. CANAL ST. CHICAGO, IL. 60606	ILLINOIS DEPARTMENT OF NATURAL RESOURCES SINNISIPPI DAM REPLACEMENT
	ALTERNATIVES 1 AND 3: PNEUMATICALLY OPERATED HINGED-LEAF GATES PLAN
	DRAWN BY: PRH CHECKED BY: QF
	DATE: AUGUST, 1995 FIG. Final 1

8/25/95 PRH

17310034


N
64'
6'
64'
6'
32'
6'
64'
6'
64'
6'
64'
6'
32'
6'
64'
6'
64'
8'
ROCK RIVER
Flow
672'
Spillway
Crest El. 636
Existing Powerhouse Forebay Wall
Concrete Pier (typ.)
34'
10'
16' for Conventional Concrete Ogee
17.5' for RCC
1' Thick Concrete Cutoff Walls
20'
Prefabricated Bridge Sections for Permanent Access (typ.)
Seven 64'-Long and Two 32'-Long Pneumatically Operated Hinged-leaf Gates (typ.)

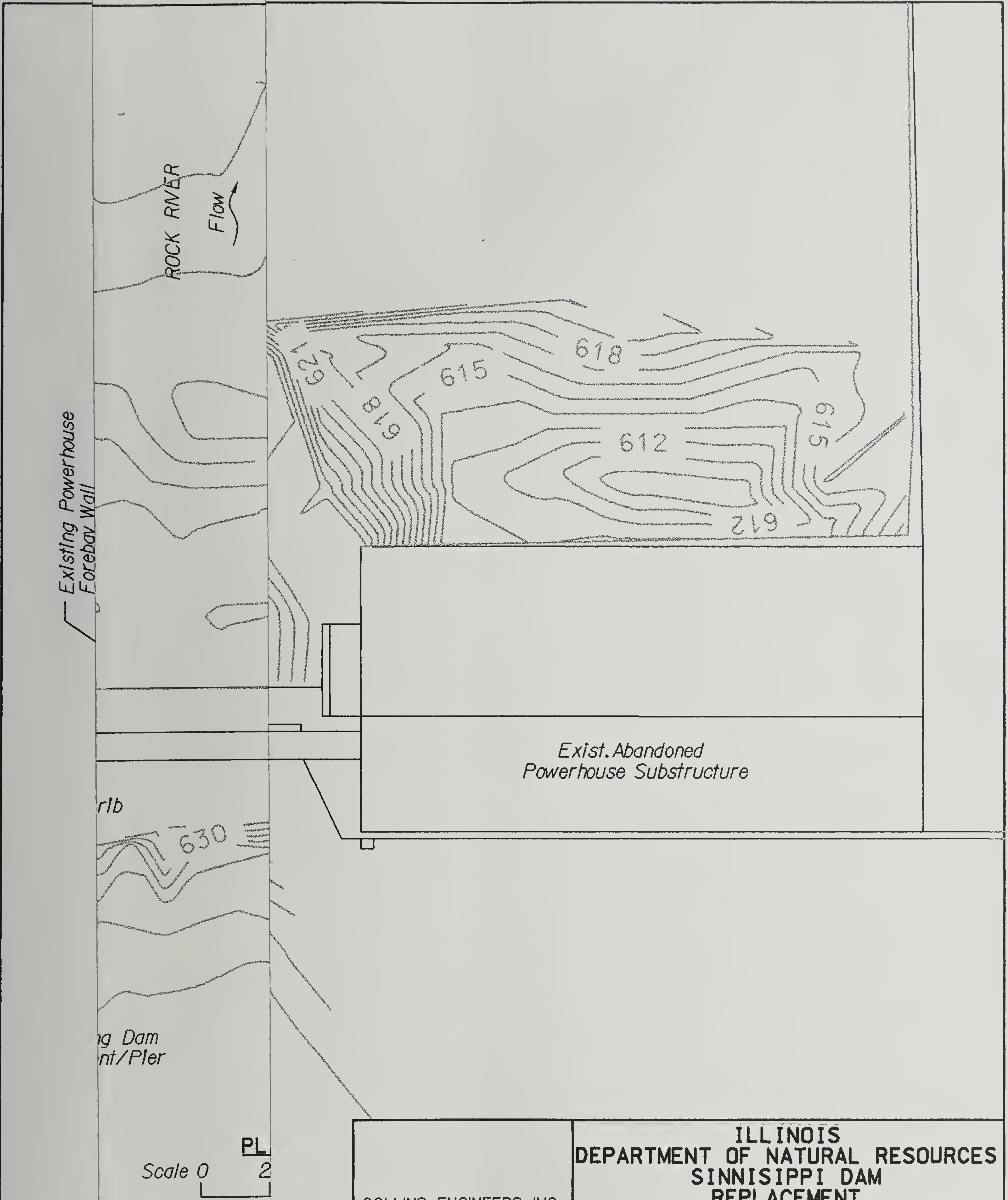
PLAN

Scale 0 20 40 Feet

COLLINS ENGINEERS, INC 165 N CANAL ST CHICAGO, IL 60606	ILLINOIS DEPARTMENT OF NATURAL RESOURCES SINNISIPPI DAM REPLACEMENT
	ALTERNATIVES 1 AND 3: PNEUMATICALLY OPERATED HINGED-LEAF GATES PLAN
	DRAWN BY PRH CHECKED BY OF
	DATE AUGUST, 1995 FIG Final 1

8/25/95 PRH

1731003A



COLLINS ENGINEERS, INC.

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 1 AND 3: PNEUMATICALLY
OPERATED HINGED-LEAF GATES

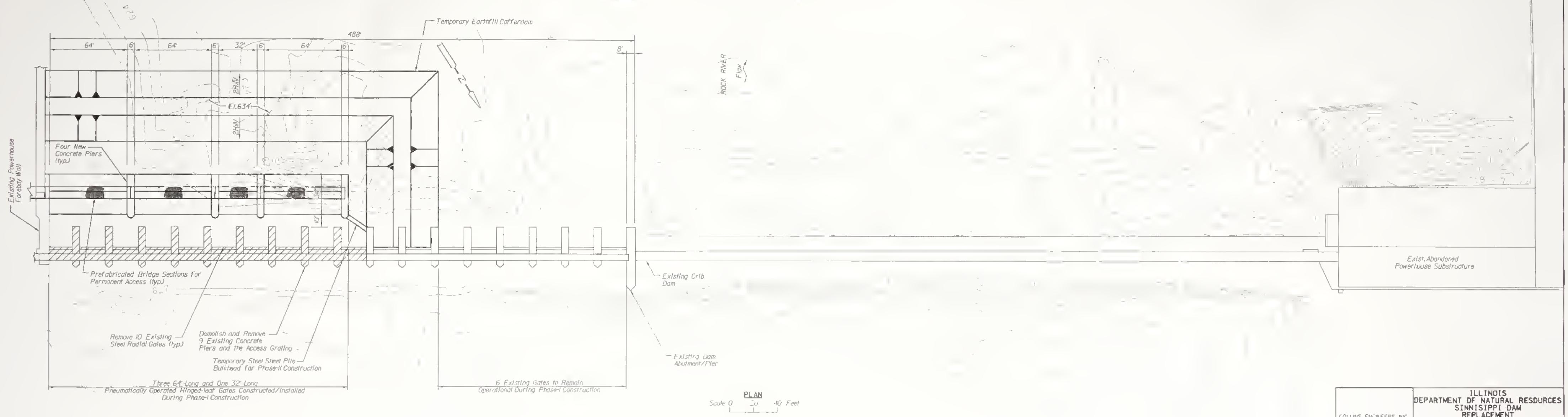
PHASE-I CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 2

8/28/95 PRH

17310036


Temporary Earthfill Cofferdam
488'
64'
6'
64'
6'
32'
6'
64'
6'
8'
2H:1V
El.634'
2H:1V
N
ROCK RIVER
Flow
Existing Powerhouse Forebay Wall
Four New Concrete Piers (typ.)
34'
10'
Prefabricated Bridge Sections for Permanent Access (typ.)
Remove 10 Existing Steel Radial Gates (typ.)
Demolish and Remove 9 Existing Concrete Piers and the Access Grating
Temporary Steel Sheet Pile Bulkhead for Phase-II Construction
Three 64'-Long and One 32'-Long Pneumatically Operated Hinged-leaf Gates Constructed/Installed During Phase-I Construction
6 Existing Gates to Remain Operational During Phase-I Construction
Existing Crib Dam
Existing Dam Abutment/Pier
Exist. Abandoned Powerhouse Substructure
PLAN
Scale 0 20 40 Feet

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SINNISIPPI DAM
REPLACEMENT

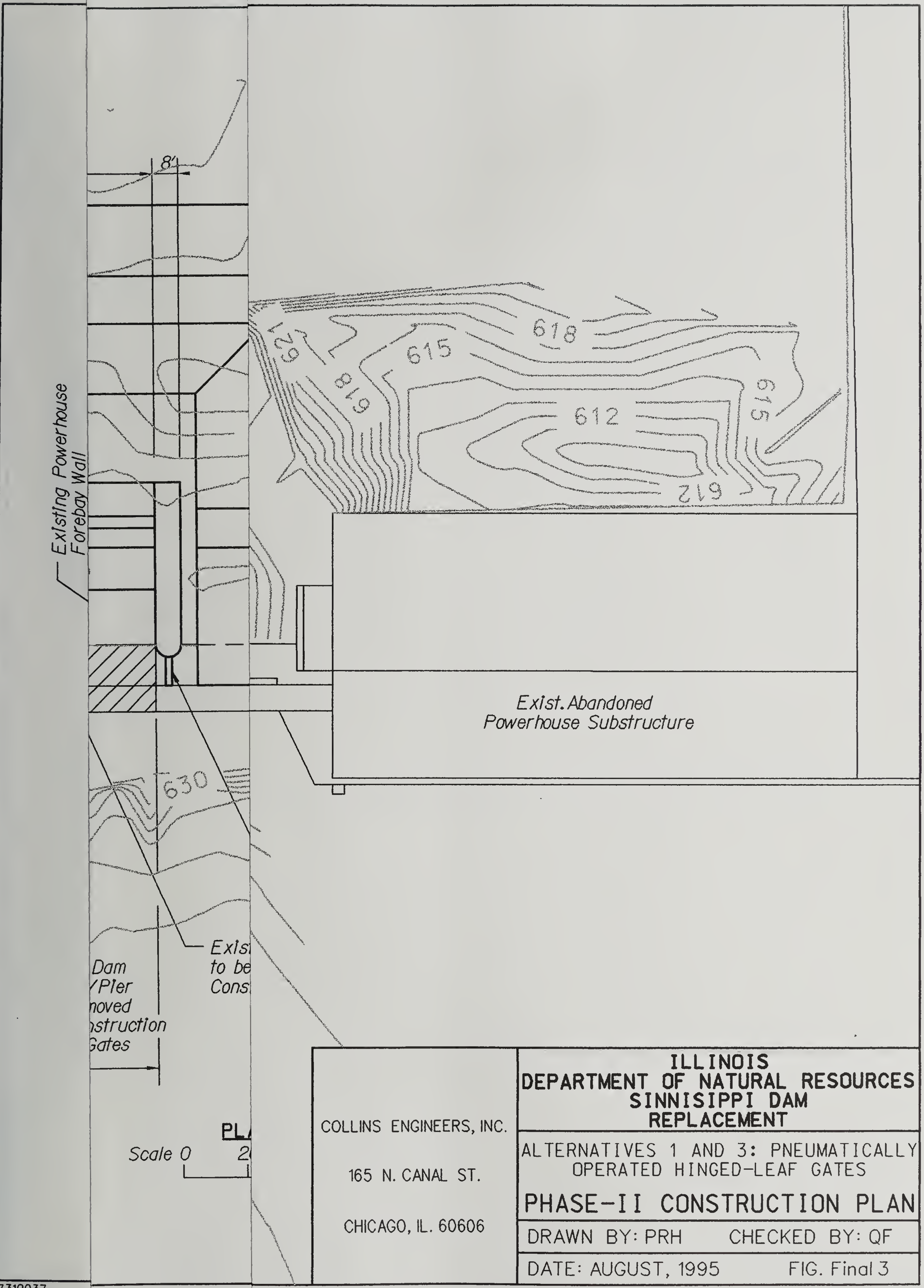
ALTERNATIVES 1 AND 3: PNEUMATICALLY OPERATED HINGED-LEAF GATES

PHASE-I CONSTRUCTION PLAN

DRAWN BY PRH CHECKED BY OF

DATE AUGUST, 1995 FIG Final 2

8/28/95 PRH



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CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 1 AND 3: PNEUMATICALLY
OPERATED HINGED-LEAF GATES

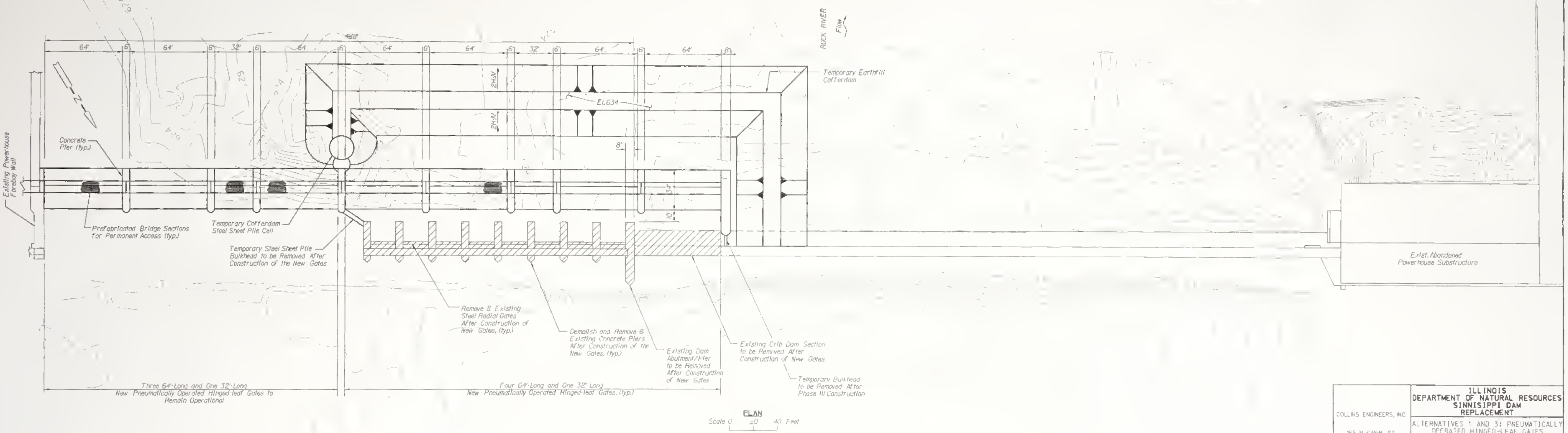
PHASE-II CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 3

8/29/95 PRH

17310037



428'
64'
6'
64'
6'
32'
6'
64
6'
64'
6'
64'
6'
32'
6'
64'
6'
64'
6'
ROCK RIVER
Flow
N
Temporary Earthfill Cofferdam
El. 634
2H:1V
2H:1V
8'
34'
10'
Existing Powerhouse Forebay Wall
Concrete Pier (typ.)
Prefabricated Bridge Sections for Permanent Access (typ.)
Temporary Cofferdam Steel Sheet Pile Cell
Temporary Steel Sheet Pile Bulkhead to be Removed After Construction of the New Gates
Remove 8 Existing Steel Radial Gates After Construction of New Gates, (typ.)
Demolish and Remove 8 Existing Concrete Piers After Construction of the New Gates. (typ.)
Existing Dam Abutment/Pier to be Removed After Construction of New Gates
Existing Crib Dam Section to be Removed After Construction of New Gates
Temporary Bulkhead to be Removed After Phase III Construction
Exist. Abandoned Powerhouse Substructure
Three 64'-Long and One 32'-Long New Pneumatically Operated Hinged-leaf Gates to Remain Operational
Four 64'-Long and One 32'-Long New Pneumatically Operated Hinged-leaf Gates. (typ.)
Scale 0 20 40 Feet

PLAN

COLLINS ENGINEERS, INC
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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 1 AND 3: PNEUMATICALLY
OPERATED HINGED-LEAF GATES

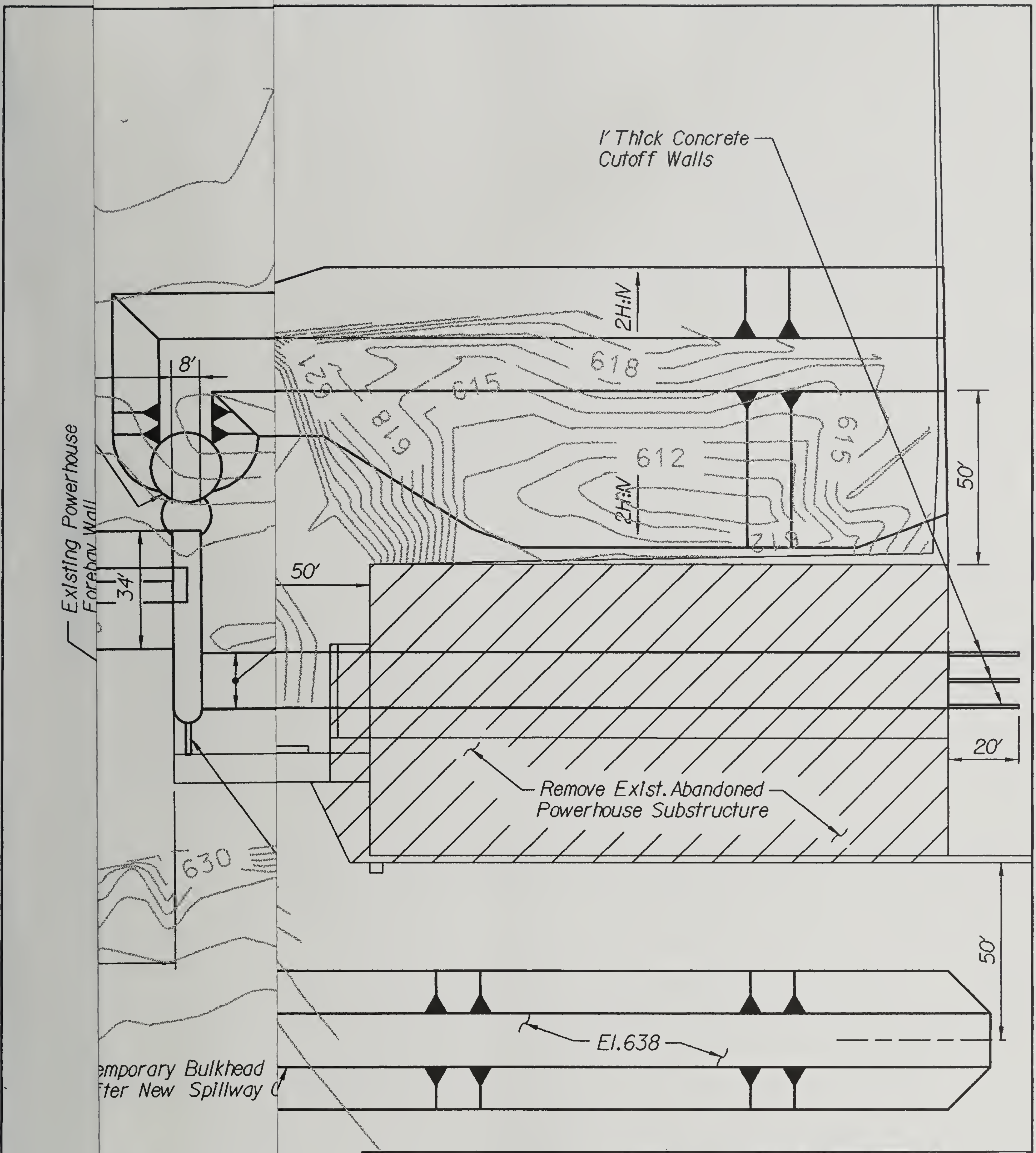
PHASE-II CONSTRUCTION PLAN

DRAWN BY PRH CHECKED BY: OF

DATE AUGUST, 1995 FIG Final 3

8/29/95 PRH

17310037



1' Thick Concrete Cutoff Walls
2H:1V
8'
618
615
619
612
615
612
2H:1V
Existing Powerhouse Forebay Wall
34'
50'
50'
20'
Remove Exist. Abandoned Powerhouse Substructure
630
50'
El.638
emporary Bulkhead
fter New Spillway C

PLAN

COLLINS ENGINEERS, INC.

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CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 1 AND 3: PNEUMATICALLY
OPERATED HINGED-LEAF GATES

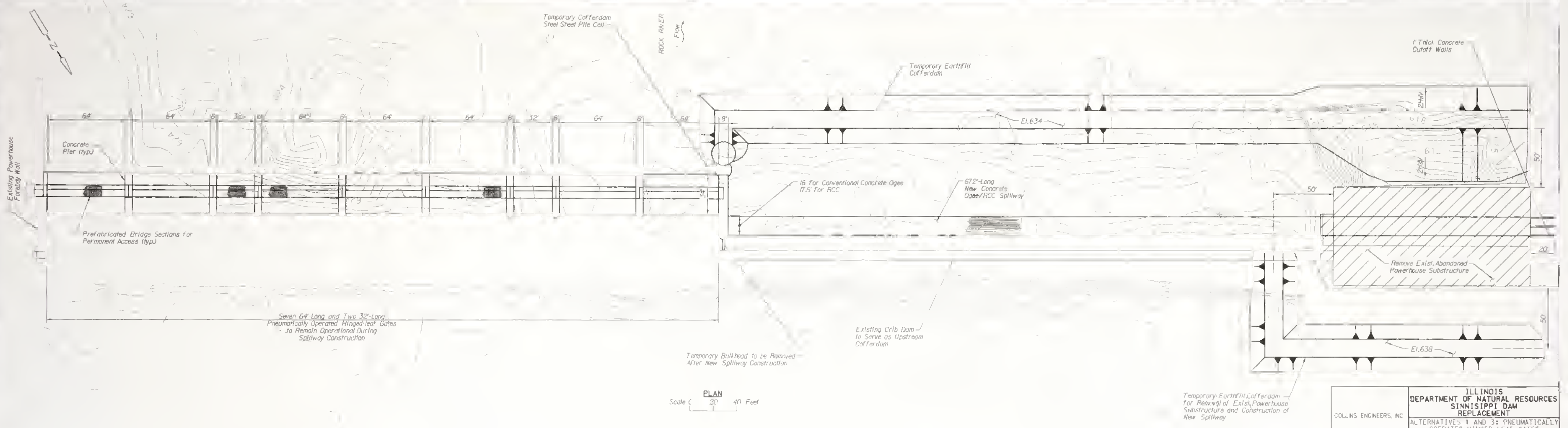
PHASE-III (SPILLWAY)
CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 4

8/28/95 PRH

17310035


N
Temporary Cofferdam Steel Sheet Pile Cell
ROCK RIVER
Flow
Temporary Earthfill Cofferdam
1' Thick Concrete Cutoff Walls
64'
64'
6'
32'
6'
64'
6'
64'
64'
6'
32'
6'
64'
6'
64'
8'
El.634
2H:1V
618
61
2H:1V
50'
Existing Powerhouse Forebay Wall
Concrete Pier (typ.)
34'
16' for Conventional Concrete Ogee
17.5' for RCC
672'-Long New Concrete Ogee/RCC Spillway
50'
20'
Prefabricated Bridge Sections for Permanent Access (typ.)
Remove Exist. Abandoned Powerhouse Substructure
Seven 64'-Long and Two 32'-Long Pneumatically Operated Hinged-leaf Gates to Remain Operational During Spillway Construction
Existing Crib Dam to Serve as Upstream Cofferdam
50'
El.638
Temporary Bulkhead to be Removed After New Spillway Construction
PLAN
Scale 0 20 40 Feet
Temporary Earthfill Cofferdam for Removal of Exist. Powerhouse Substructure and Construction of New Spillway

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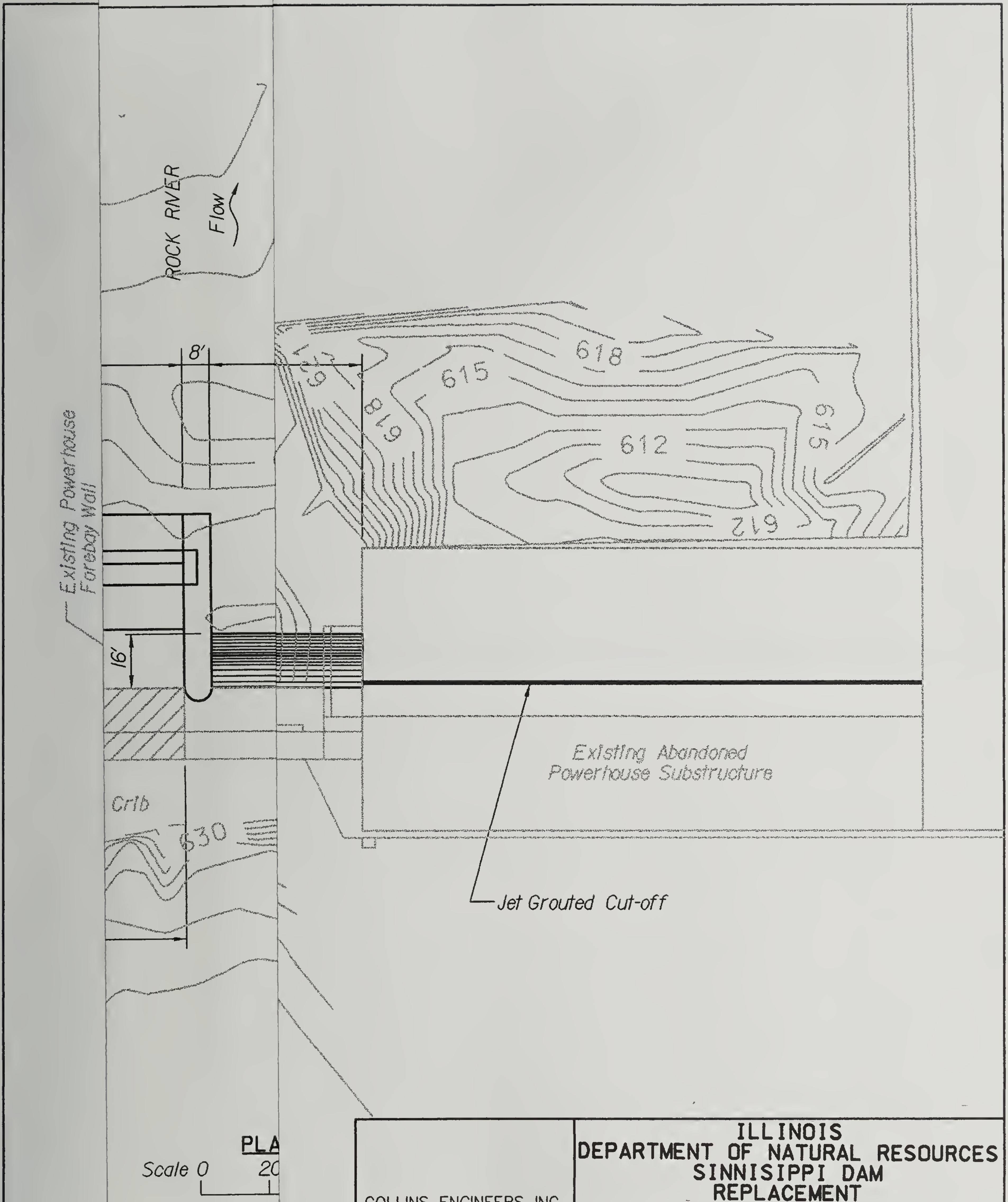
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 1 AND 3: PNEUMATICALLY OPERATED HINGED-LEAF GATES
PHASE-III (SPILLWAY)
CONSTRUCTION PLAN

DRAWN BY PRH CHECKED BY QF
DATE AUGUST, 1995 FIG Final 4



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DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

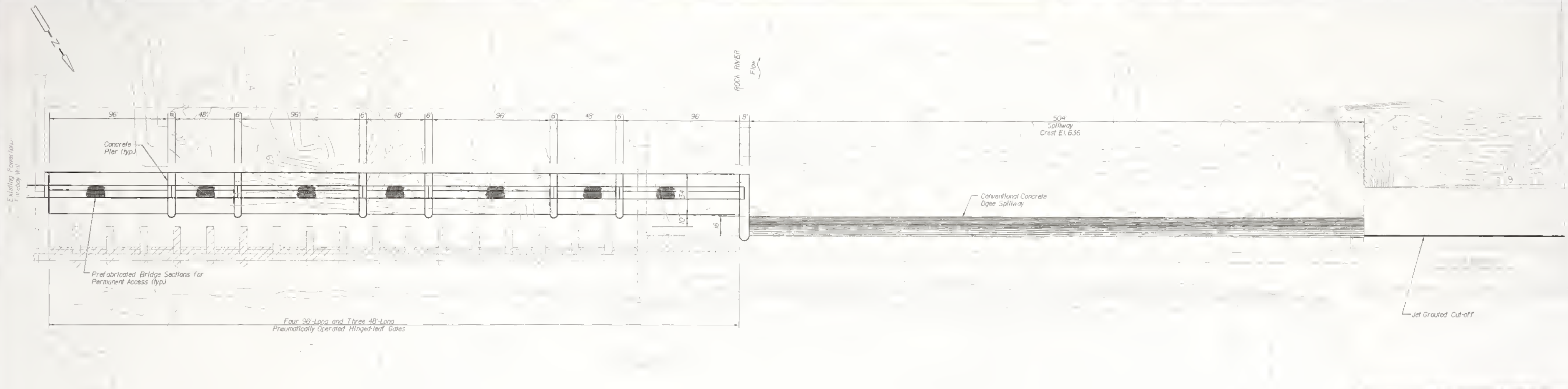
ALTERNATIVE 2: PNEUM. OP. HINGED-LEAF
GATES W/ CONVENTIONAL CONC. SPILL.
W/O REMOVING EXIST. P.H.
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 5

9/15/95 PRH

17310042


N
ROCK RIVER
Flow
96'
6'
48'
6'
96'
6'
48'
6'
96'
6'
48'
6'
96'
8'
504'
Spillway
Crest El. 636
Existing Powerhouse Forebay Wall
Concrete Pier (typ.)
54
10
16
Conventional Concrete Ogee Spillway
Prefabricated Bridge Sections for Permanent Access (typ.)
Four 96'-Long and Three 48'-Long Pneumatically Operated Hinged-leaf Gates
Jet Grouted Cut-off

PLAN

Scale 0 20 40 Feet

COLLINS ENGINEERS, INC
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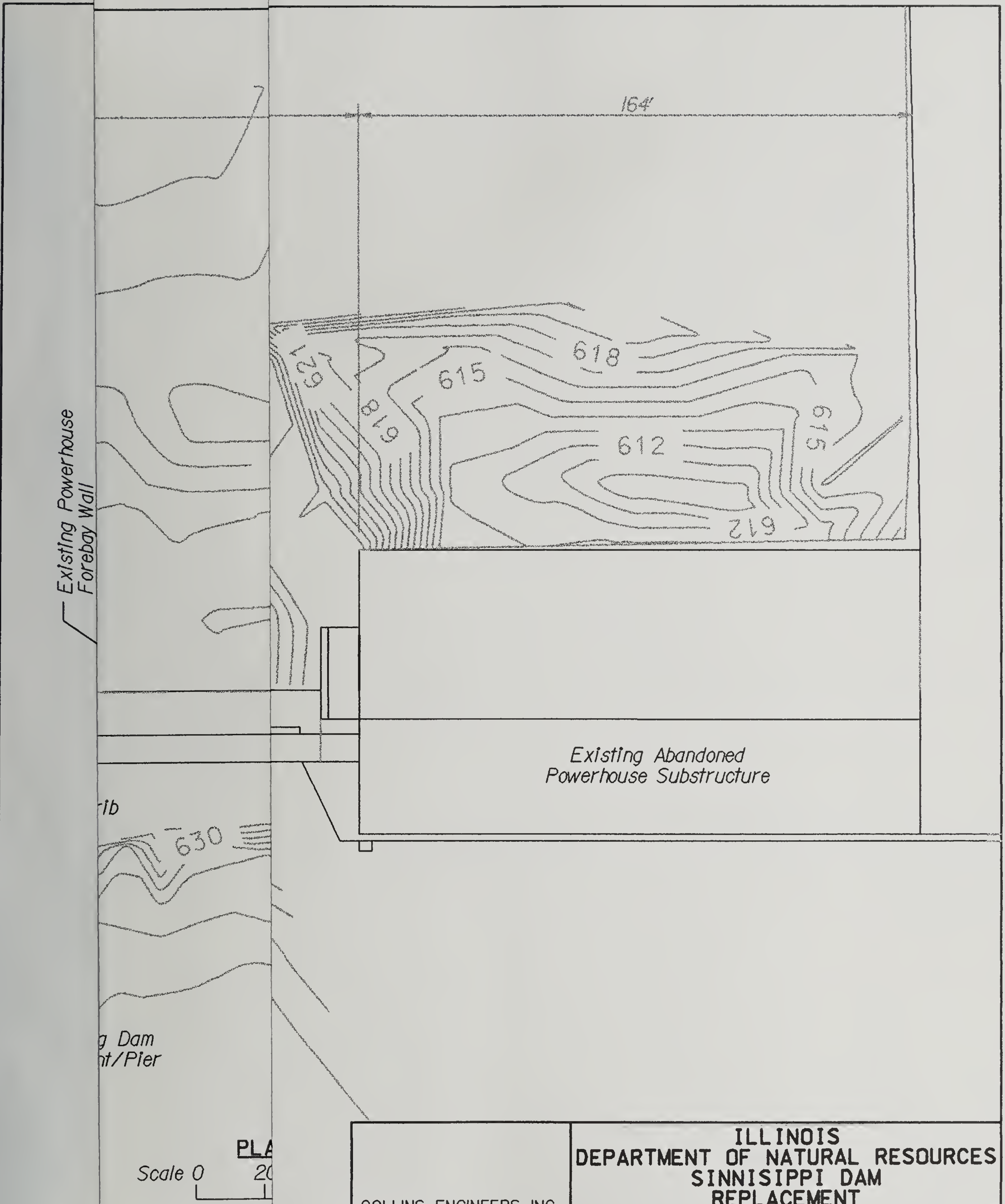
CHICAGO, IL 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 2: PNEUM. OP. HINGED-LEAF
GATES W/ CONVENTIONAL CONC. SPILL.
W/O REMOVING EXIST. P.H.
PLAN

DRAWN BY PRH CHECKED BY. OF

DATE AUGUST 1995 FIG Final 5



COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 2: PNEUM. OP. HINGED-LEAF
GATES W/ CONVENTIONAL CONC. SPILL.
W/O REMOVING EXIST. P.H.

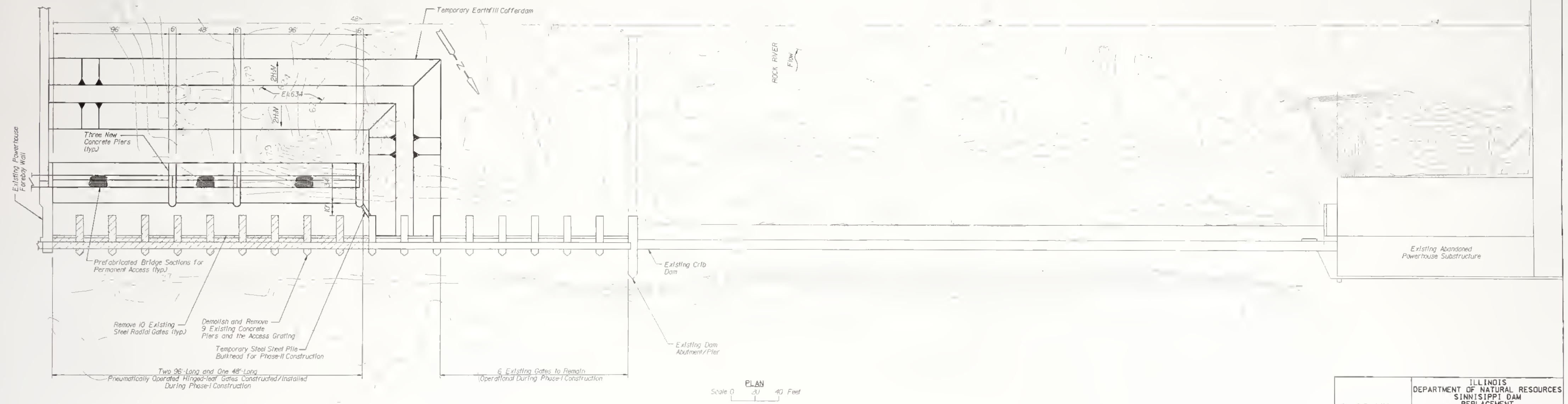
PHASE-I CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 6

9/14/95 PRH

17310043


Temporary Earthfill Cofferdam
48'
96'
6'
48'
6'
96'
6'
2H:1V
El.634
2H:1V
N
ROCK RIVER
Flow
Existing Powerhouse Forebay Wall
Three New Concrete Piers (typ.)
34'
10'
Prefabricated Bridge Sections for Permanent Access (typ.)
Existing Crib Dam
Existing Abandoned Powerhouse Substructure
Remove 10 Existing Steel Radial Gates (typ.)
Demolish and Remove 9 Existing Concrete Piers and the Access Grating
Temporary Steel Sheet Pile Bulkhead for Phase-II Construction
Existing Dam Abutment/Pier
Two 96'-Long and One 48'-Long Pneumatically Operated Hinged-leaf Gates Constructed/Installed During Phase-I Construction
6 Existing Gates to Remain Operational During Phase-I Construction
PLAN
Scale 0 20 40 Feet

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DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

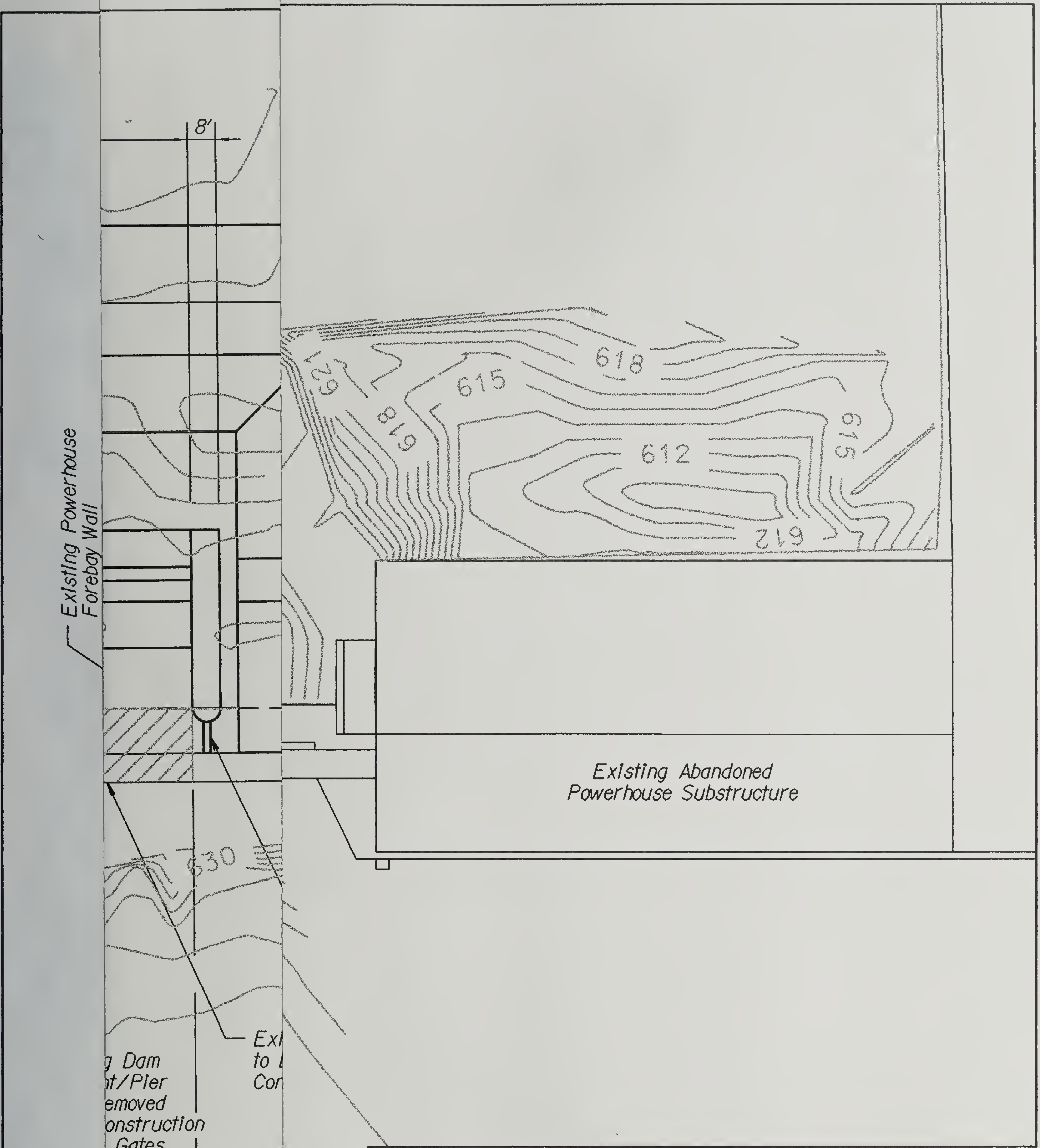
ALTERNATIVE 2: PNEUM. OP. HINGED-LEAF
GATES W/ CONVENTIONAL CONC. SPILL.
W/O REMOVING EXIST. P.H.

PHASE-I CONSTRUCTION PLAN

DRAWN BY PRH CHECKED BY QF

DATE AUGUST, 1995 FIG Final6

9/14/95 PRH
17310043



COLLINS ENGINEERS, INC.

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CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 2: PNEUM. OP. HINGED-LEAF GATES W/ CONVENTIONAL CONC. SPILL. W/O REMOVING EXIST. P.H.

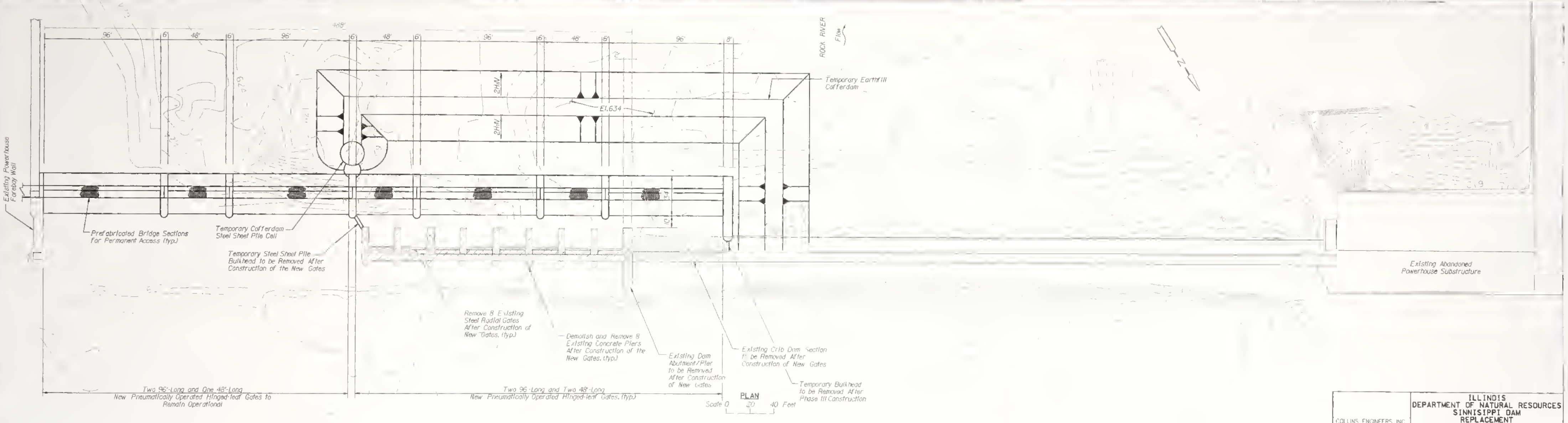
PHASE-II CONSTRUCTION PLAN

DRAWN BY: PRH
CHECKED BY: QF

DATE: AUGUST, 1995
FIG. Final 7

9/13/95 PRH

17310044


488'
96'
6'
48'
6'
96'
6'
48'
6'
96'
6'
48'
6'
96'
8'
ROCK RIVER
Flow
N
Temporary Earthfill Cofferdam
2H:1V
2H:1V
El.634
Existing Powerhouse Forebay Wall
34'
10'
Prefabricated Bridge Sections for Permanent Access (typ.)
Temporary Cofferdam Steel Sheet Pile Cell
Temporary Steel Sheet Pile Bulkhead to be Removed After Construction of the New Gates
Existing Abandoned Powerhouse Substructure
Remove 8 Existing Steel Radial Gates After Construction of New Gates. (typ.)
Demolish and Remove 8 Existing Concrete Piers After Construction of the New Gates. (typ.)
Existing Dam Abutment/Pier to be Removed After Construction of New Gates
Existing Crib Dam Section to be Removed After Construction of New Gates
Temporary Bulkhead to be Removed After Phase III Construction
Two 96'-Long and One 48'-Long New Pneumatically Operated Hinged-leaf Gates to Remain Operational
Two 96'-Long and Two 48'-Long New Pneumatically Operated Hinged-leaf Gates. (typ.)
PLAN
Scale 0 20 40 Feet

COLLINS ENGINEERS, INC
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CHICAGO, IL 60606

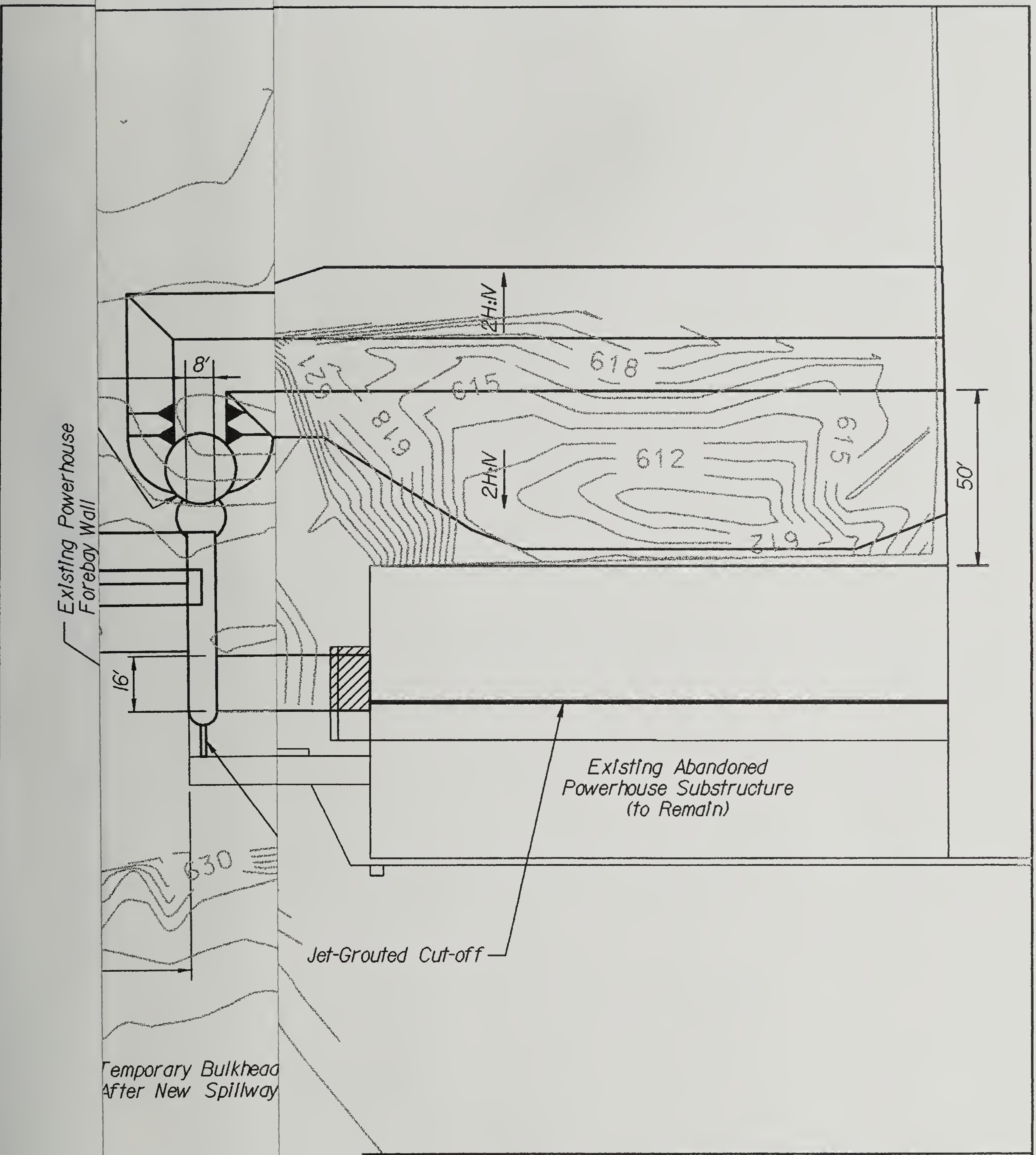
ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 2: PNEUM. OP. HINGED-LEAF GATES W/ CONVENTIONAL CONC. SPILL. W/O REMOVING EXIST. P.H.

PHASE-II CONSTRUCTION PLAN

DRAWN BY PRH CHECKED BY OF

DATE AUGUST, 1995 FIG Final 7


2H:1V
8'
618
615
612
50'
Existing Powerhouse Forebay Wall
16'
Existing Abandoned Powerhouse Substructure (to Remain)
630
Jet-Grouted Cut-off
Temporary Bulkhead
After New Spillway

PL

Scale 0 2

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DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 2: PNEUM. OP. HINGED-LEAF GATES W/ CONVENTIONAL CONC. SPILL. W/O REMOVING EXIST. P.H.

PHASE-III CONSTRUCTION PLAN

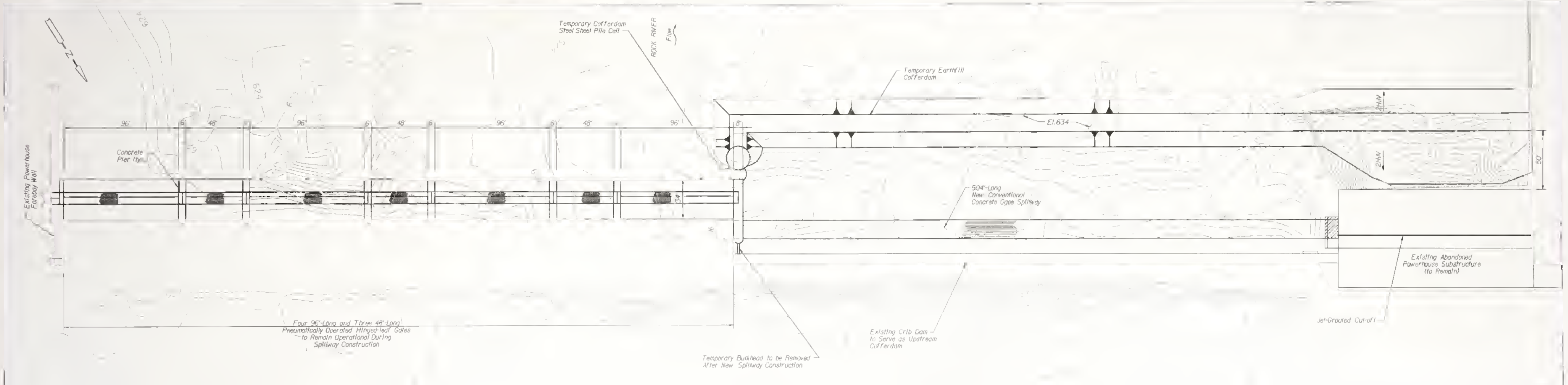
DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 8

9/13/95 PRH

8

17310045



PLAN
Scale 0 20 40 Feet

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CHICAGO IL 60606

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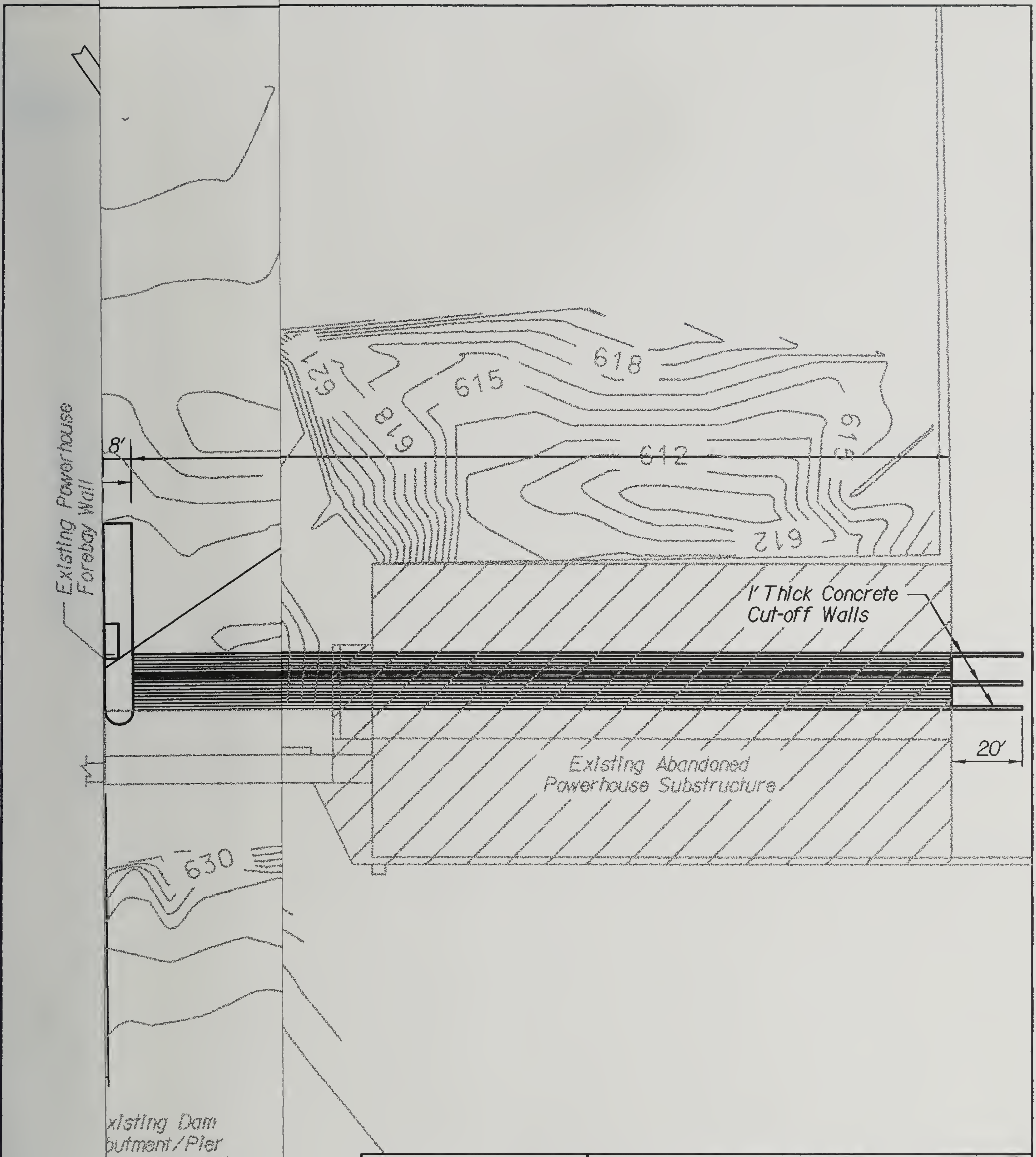
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 2: PNEUM. OP. HINGED-LEAF
GATES W CONVENTIONAL CONC. SPILL.
W/O REMOVING EXIST. P.H.
PHASE-III CONSTRUCTION PLAN

DRAWN BY PRH CHECKED BY OF
DATE AUGUST, 1995 FIG Final 8

17310045


618
615
618
612
615
612
627
8'
Existing Powerhouse Forebay Wall
I' Thick Concrete Cut-off Walls
20'
Existing Abandoned Powerhouse Substructure
630
xisting Dam
butment/Pier
be Removed)

40 Feet

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SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 4 AND 6: HYDRAULIC
CYLINDER OPERATED HINGED-LEAF GATES

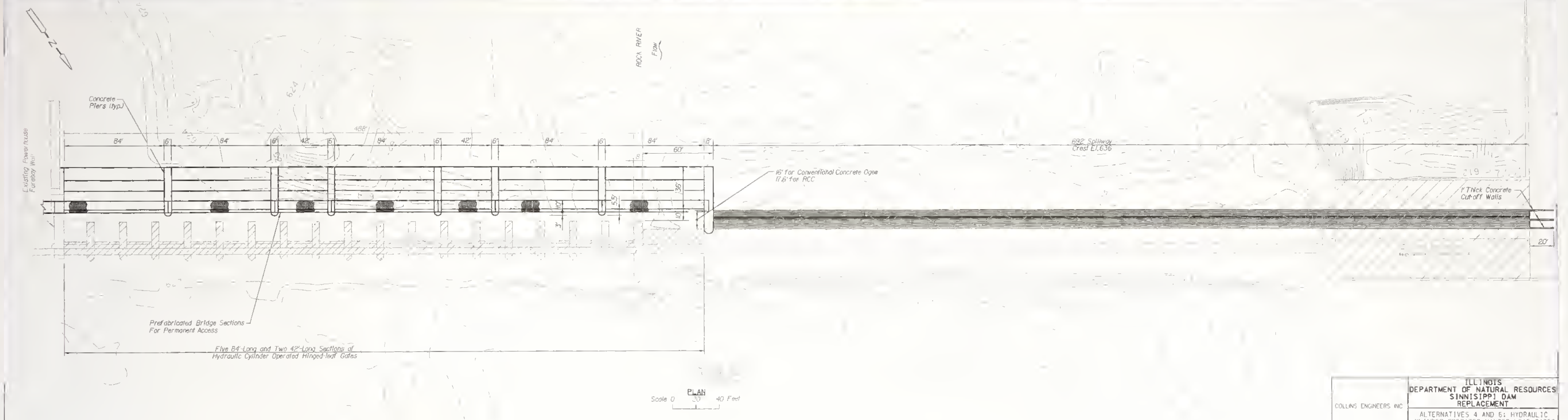
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 9

8/28/95 PRH

17310038


N
ROCK RIVER
Flow
Existing Powerhouse Forebay Wall
Concrete Piers (typ.)
488'
84'
6'
84'
6'
42'
6'
84'
6'
42'
6'
84'
6'
84'
8'
60'
8
36'
5.5'
10'
10
3'
16' for Conventional Concrete Ogee
17.6' for RCC
692' Spillway Crest El. 636
1' Thick Concrete Cut-off Walls
20'
624
Prefabricated Bridge Sections For Permanent Access
Five 84'-Long and Two 42'-Long Sections of Hydraulic Cylinder Operated Hinged-leaf Gates
PLAN
Scale 0 20 40 Feet

COLLINS ENGINEERS INC

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ILLINOIS
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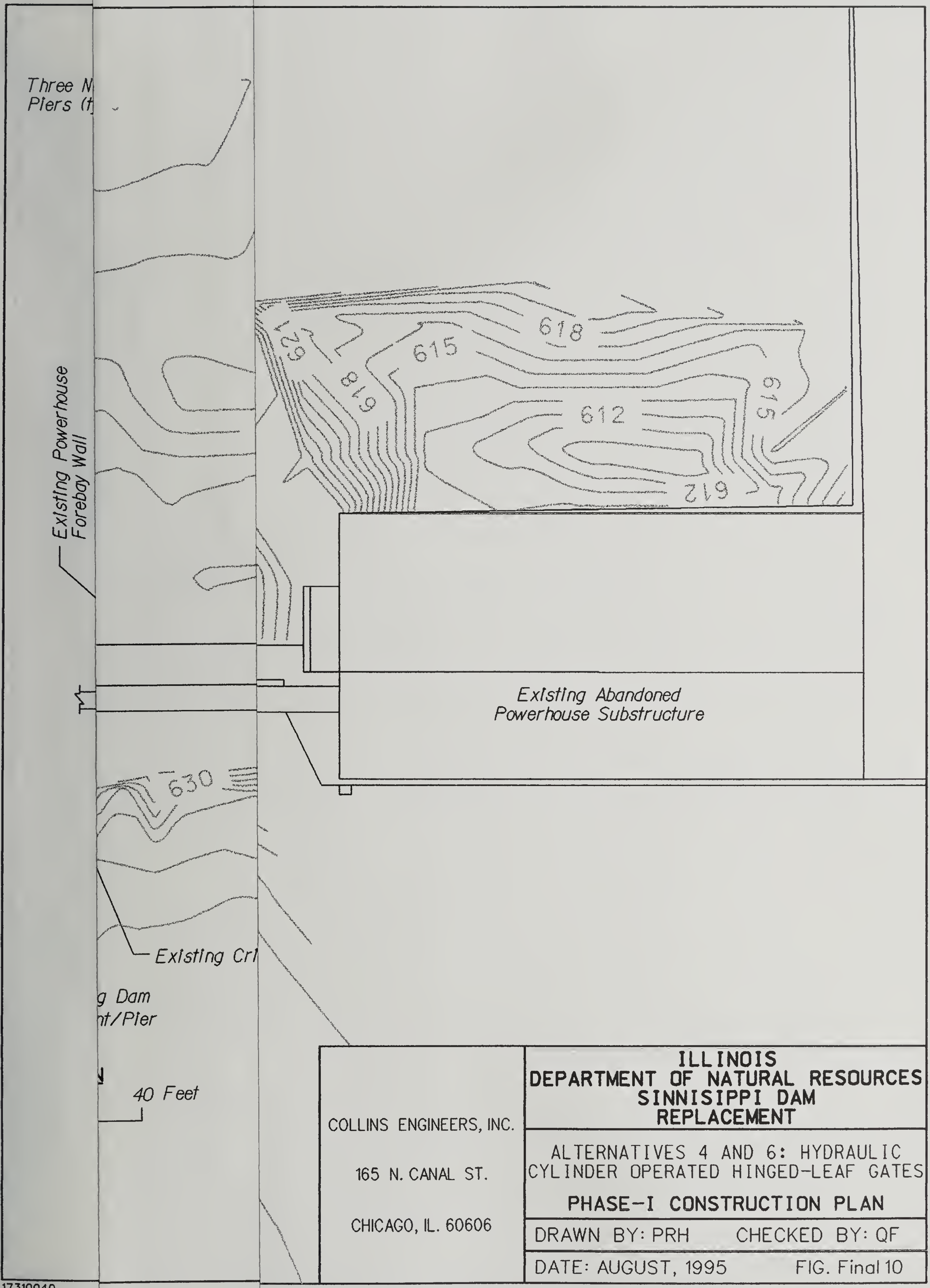
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 4 AND 6: HYDRAULIC
CYLINDER OPERATED HINGED-LEAF GATES

PLAN

DRAWN BY PRH CHECKED BY QF

DATE AUGUST, 1995 FIG Final 9



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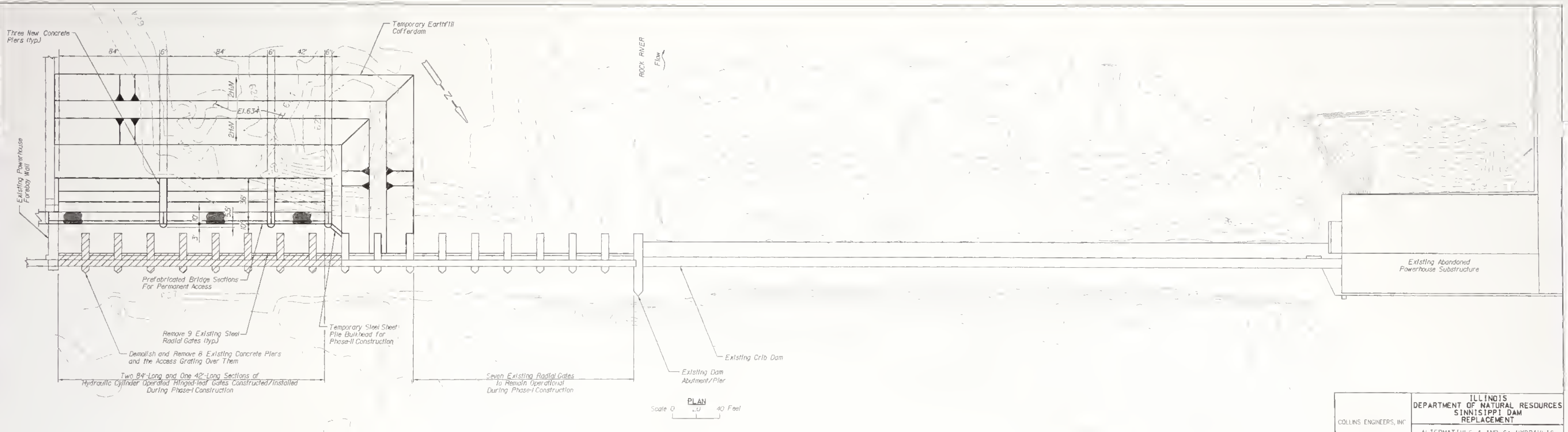
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 4 AND 6: HYDRAULIC
CYLINDER OPERATED HINGED-LEAF GATES

PHASE-I CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 10


Three New Concrete Piers (typ.)
Temporary Earthfill Cofferdam
84'
6'
84'
6'
42'
6'
2H:1V
El.634
2H:1V
629
629
621
N
ROCK RIVER
Flow
Existing Powerhouse Forebay Wall
36'
5.5'
10'
10'
3'
Prefabricated Bridge Sections For Permanent Access
Existing Abandoned Powerhouse Substructure
Remove 9 Existing Steel Radial Gates (typ.)
Temporary Steel Sheet Pile Bulkhead for Phase-II Construction
Demolish and Remove 8 Existing Concrete Piers and the Access Grating Over Them
Existing Crib Dam
Existing Dam Abutment/Pier
Two 84'-Long and One 42'-Long Sections of Hydraulic Cylinder Operated Hinged-leaf Gates Constructed/Installed During Phase-I Construction
Seven Existing Radial Gates to Remain Operational During Phase-I Construction
PLAN
Scale 0 20 40 Feet

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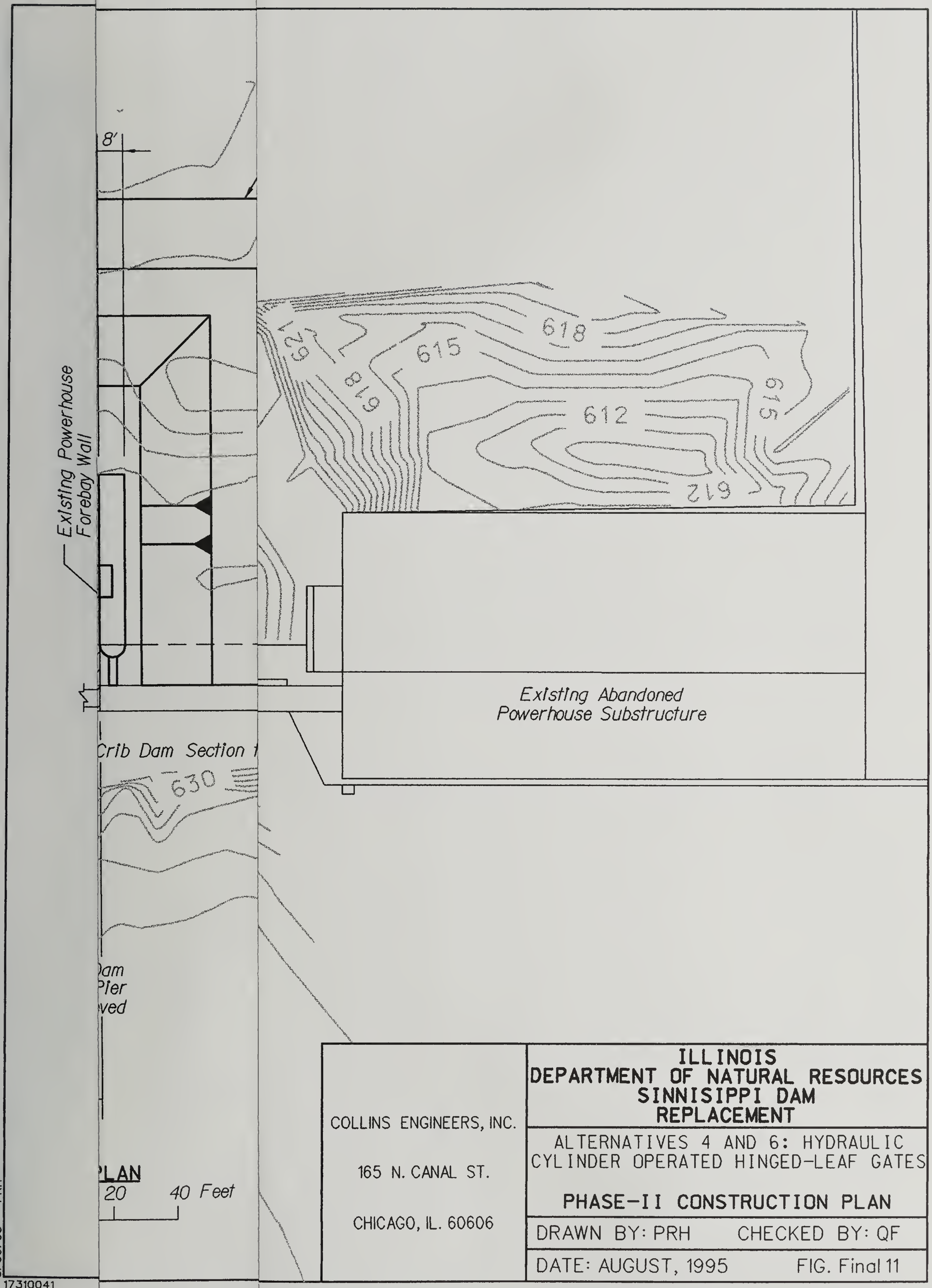
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 4 AND 6: HYDRAULIC
CYLINDER OPERATED HINGED-LEAF GATES

PHASE-I CONSTRUCTION PLAN

DRAWN BY PRH CHECKED BY OF

DATE AUGUST, 1995 FIG Final 10


8'
Existing Powerhouse Forebay Wall
621
618
615
618
612
615
612
Existing Abandoned Powerhouse Substructure
Crib Dam Section
630
Dam
Pier
ved
PLAN
20
40 Feet

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 4 AND 6: HYDRAULIC
CYLINDER OPERATED HINGED-LEAF GATES

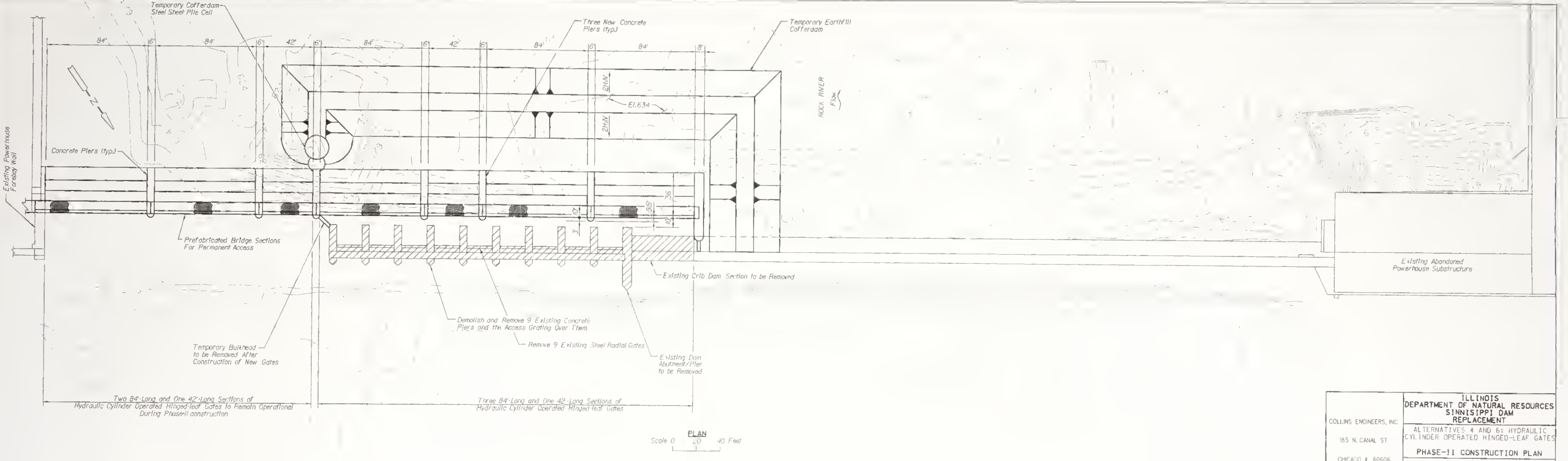
PHASE-II CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 11

8/30/95 PRH

17310041


Temporary Cofferdam Steel Sheet Pile Cell
Three New Concrete Piers (typ.)
Temporary Earthfill Cofferdam
84'
6'
84'
6'
42'
6'
84'
6'
42'
6'
84'
6'
84'
8'
N
2H:1V
El. 634
2H:1V
ROCK RIVER
Flow
Existing Powerhouse Forebay Wall
Concrete Piers (typ.)
36
5.5'
10'
10'
3'
Prefabricated Bridge Sections For Permanent Access
Existing Crib Dam Section to be Removed
Existing Abandoned Powerhouse Substructure
Demolish and Remove 9 Existing Concrete Piers and the Access Grating Over Them
Remove 9 Existing Steel Radial Gates
Temporary Bulkhead to be Removed After Construction of New Gates
Existing Dam Abutment/Pier to be Removed
Two 84'-Long and One 42'-Long Sections of Hydraulic Cylinder Operated Hinged-leaf Gates to Remain Operational During Phase-II construction
Three 84'-Long and One 42'-Long Sections of Hydraulic Cylinder Operated Hinged-leaf Gates
PLAN
Scale 0 20 40 Feet
8/30/95 PRH
17310041

COLLINS ENGINEERS, INC.
185 N. CANAL ST
CHICAGO, IL 60606

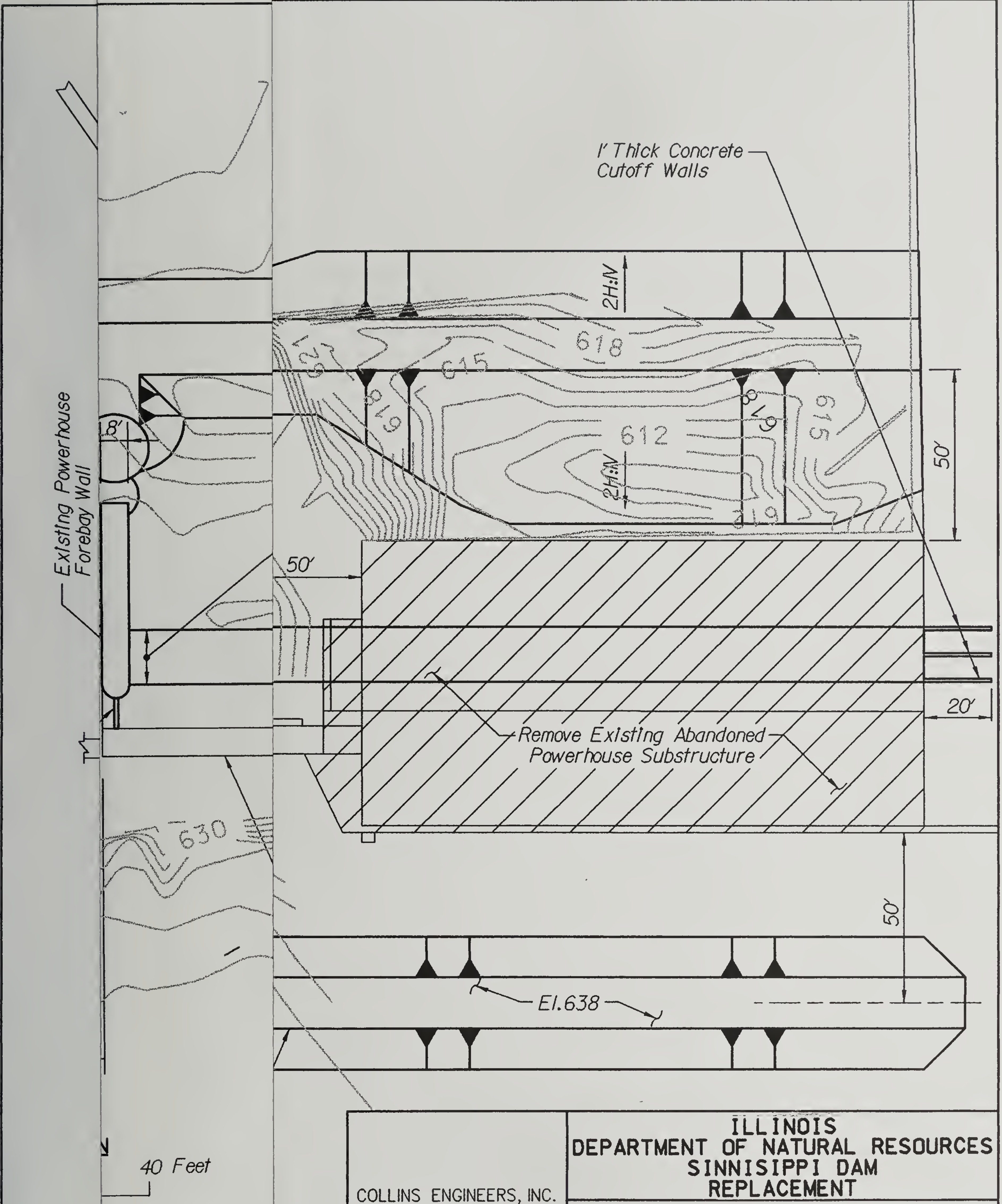
ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 4 AND 6: HYDRAULIC CYLINDER OPERATED HINGED-LEAF GATES

PHASE-II CONSTRUCTION PLAN

DRAWN BY PRH CHECKED BY OF

DATE AUGUST, 1995 FIG Final 11


1' Thick Concrete Cutoff Walls
2H:1V
618
615
612
619
621
18'
Existing Powerhouse Forebay Wall
50'
20'
Remove Existing Abandoned Powerhouse Substructure
630
El.638
40 Feet

COLLINS ENGINEERS, INC.

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CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 4 AND 6: HYDRAULIC CYLINDER OPERATED HINGED-LEAF GATES

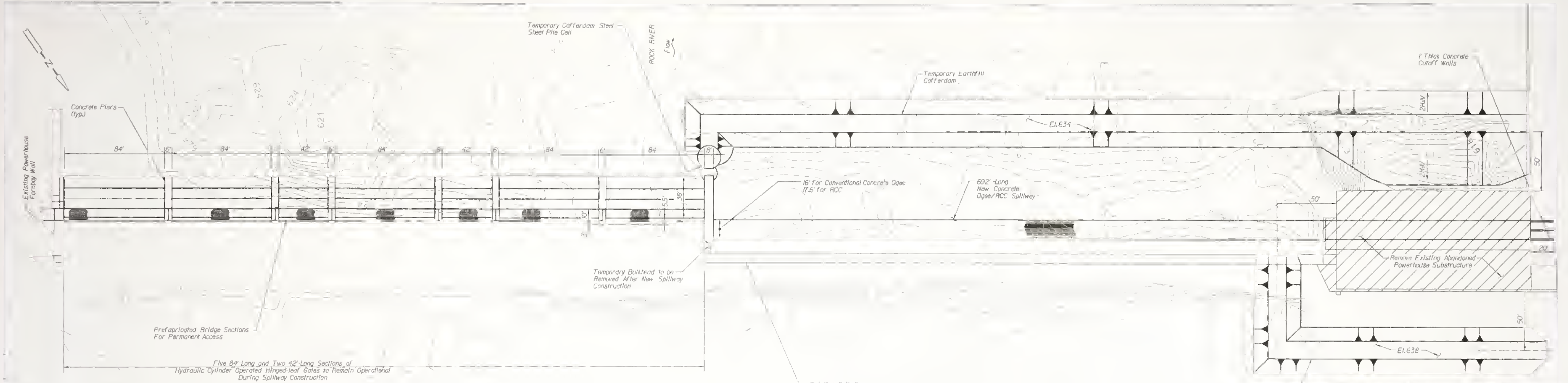
PHASE-III (SPILLWAY)
CONSTRUCTION PLAN

DRAWN BY: PRH   CHECKED BY: QF

DATE: AUGUST, 1995   FIG. Final 12

8/28/95 PRH
17310039

12


N
Existing Powerhouse Forebay Wall
Concrete Piers (typ.)
84'
6'
84'
42'
6'
84'
6'
42'
6'
84
6'
84
8'
5.5'
36'
10'
3'
624
624
621
Temporary Cofferdam Steel Sheet Pile Cell
ROCK RIVER
Flow
Temporary Earthfill Cofferdam
El.634
1' Thick Concrete Cutoff Walls
2H:1V
2H:1V
50'
16' for Conventional Concrete Ogee 17.6' for RCC
692' -Long New Concrete Ogee/RCC Spillway
50'
20'
Remove Existing Abandoned Powerhouse Substructure
Temporary Bulkhead to be Removed After New Spillway Construction
Prefabricated Bridge Sections For Permanent Access
Five 84'-Long and Two 42'-Long Sections of Hydraulic Cylinder Operated Hinged-leaf Gates to Remain Operational During Spillway Construction
50'
El.638
Existing Crib Dam to Serve as Upstream Cofferdam
Temporary Earthfill Cofferdam for Removal of Exist. Powerhouse Substructure and Construction of New Spillway

PLAN

Scale 0 20 40 Feet

COLLINS ENGINEERS, INC
165 N CANAL ST
CHICAGO, IL 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

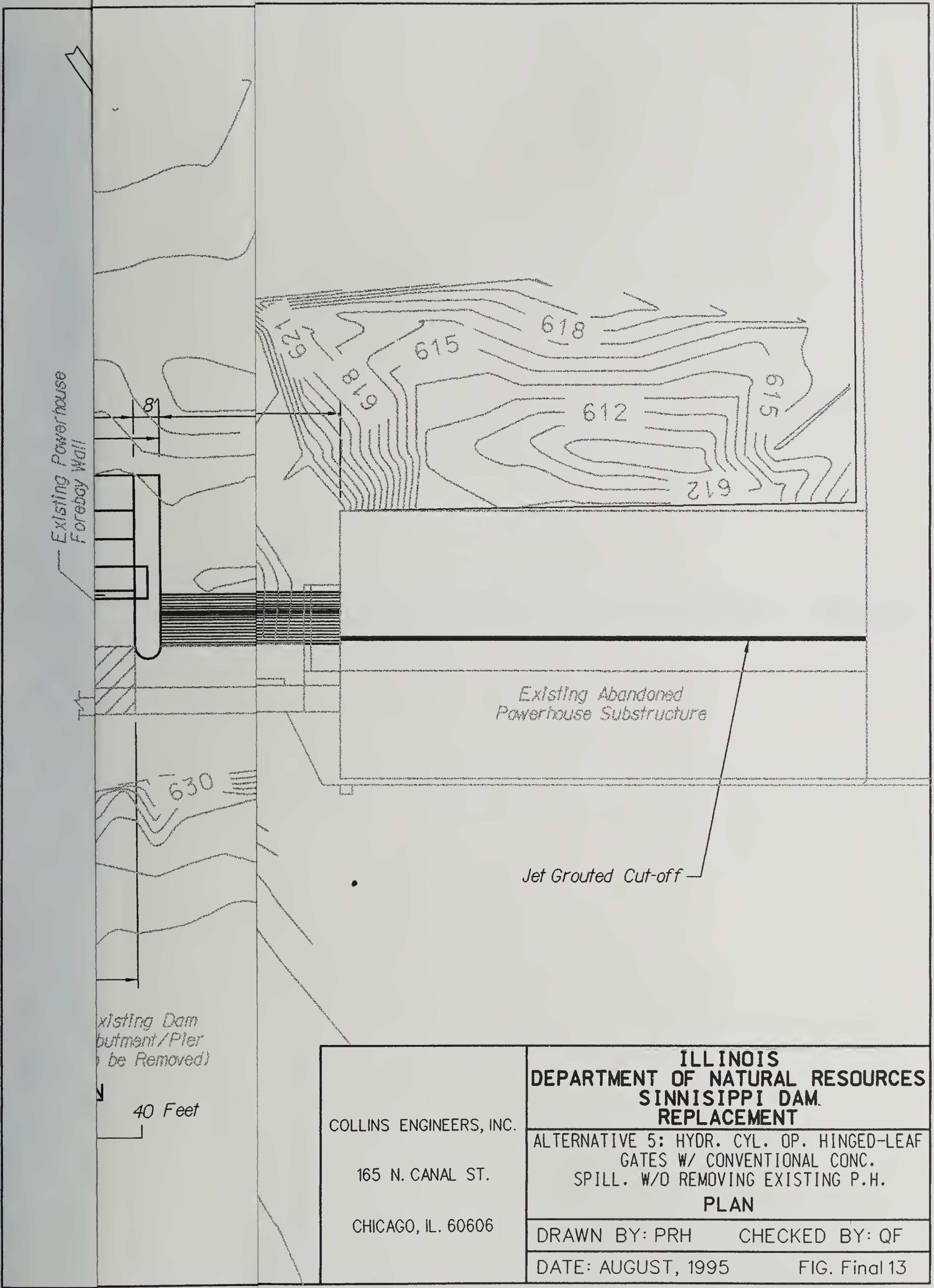
ALTERNATIVES 4 AND 6: HYDRAULIC CYLINDER OPERATED HINGED-LEAF GATES

PHASE-III (SPILLWAY)
CONSTRUCTION PLAN

DRAWN BY PRH CHECKED BY QF

DATE AUGUST, 1995 FIG Final 12

17310039



COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 5: HYDR. CYL. OP. HINGED-LEAF
GATES W/ CONVENTIONAL CONC.
SPILL. W/O REMOVING EXISTING P.H.

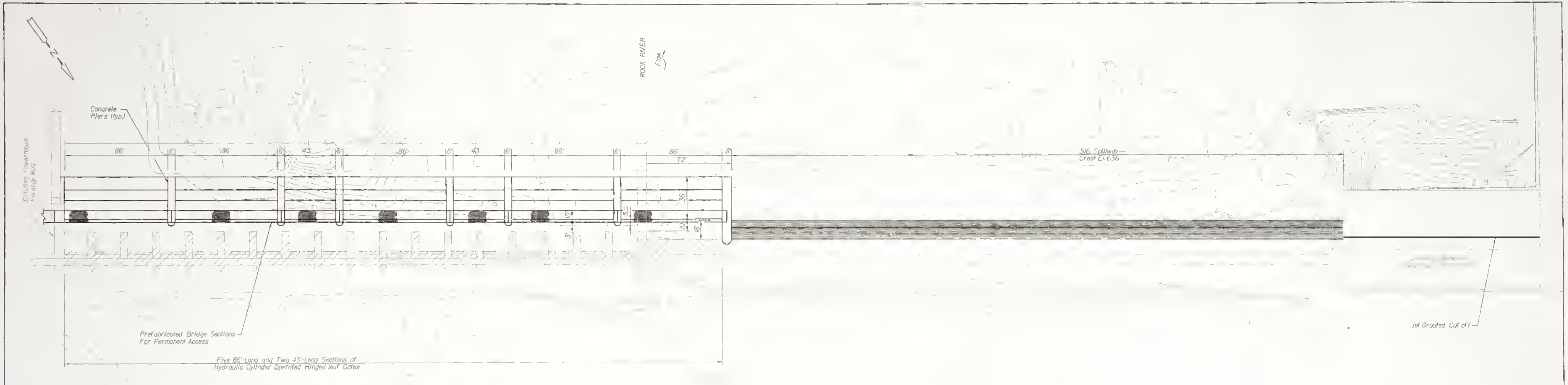
PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 13

9/13/95 PRH

17310046


N
ROCK RIVER
Flow
Concrete Piers (typ.)
Existing Powerhouse Forebay Wall
86'
6'
86'
6'
43
6'
86'
6'
43
6'
86'
6'
86'
72'
8'
36'
55
10'
10'
16'
3'
516 Spillway Crest El. 636
Prefabricated Bridge Sections For Permanent Access
Five 86'-Long and Two 43'-Long Sections of Hydraulic Cylinder Operated Hinged-leaf Gates
Jet Grouted Cut-off

PLAN

Scale 0 20 40 Feet

COLLINS ENGINEERS, INC

165 N CANAL ST

CHICAGO, IL 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

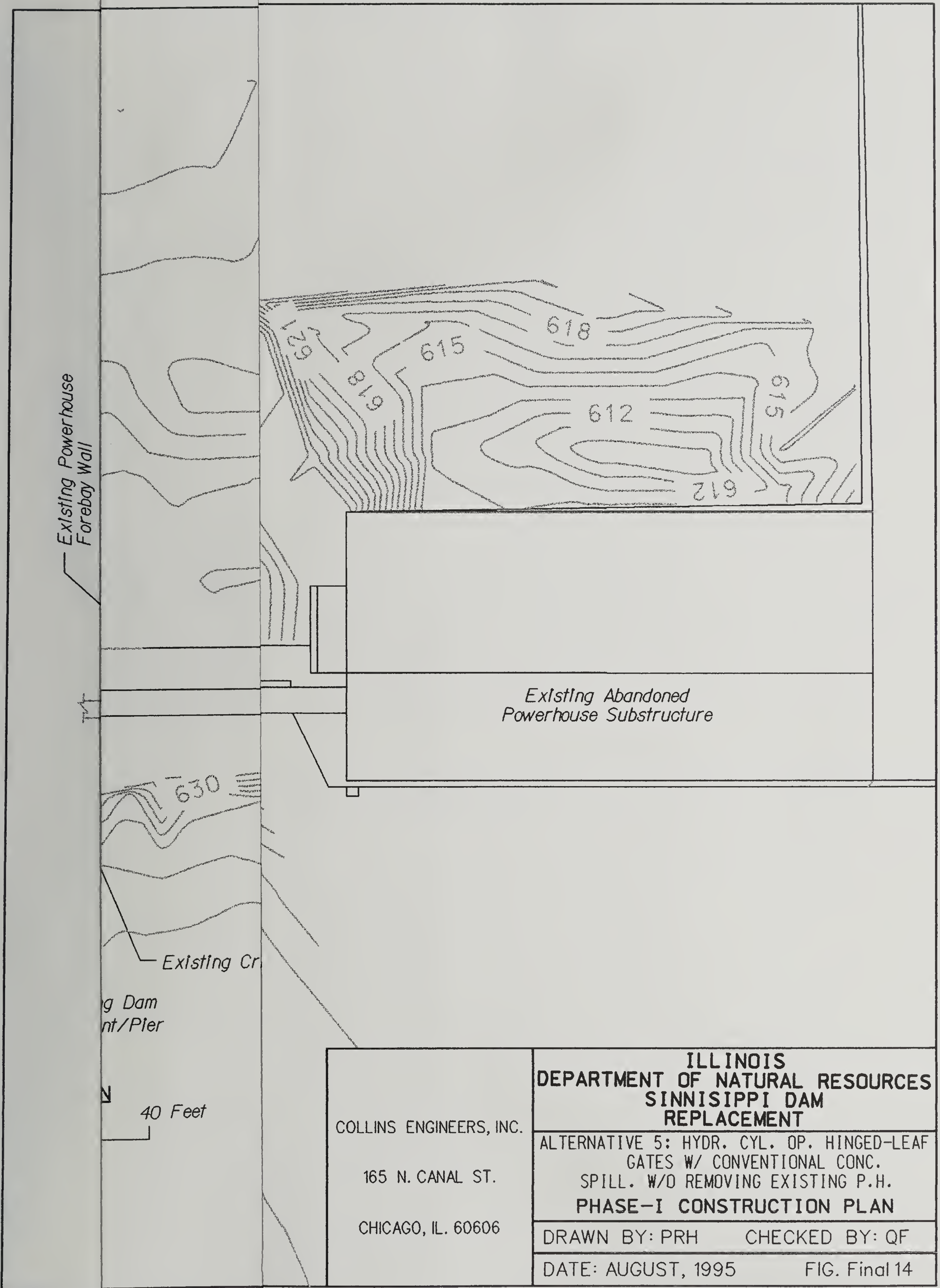
ALTERNATIVE 5: HYDR. CYL. OP. HINGED-LEAF
GATES W/ CONVENTIONAL CONC.
SPILL. W/O REMOVING EXISTING P.H.

PLAN

DRAWN BY PRH CHECKED BY OF

DATE AUGUST, 1995 FIG Final 13

17310048


Existing Powerhouse Forebay Wall
621
618
615
618
612
615
612
Existing Abandoned Powerhouse Substructure
630
Existing Cr
g Dam
nt/Pier
40 Feet

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 5: HYDR. CYL. OP. HINGED-LEAF
GATES W/ CONVENTIONAL CONC.
SPILL. W/O REMOVING EXISTING P.H.

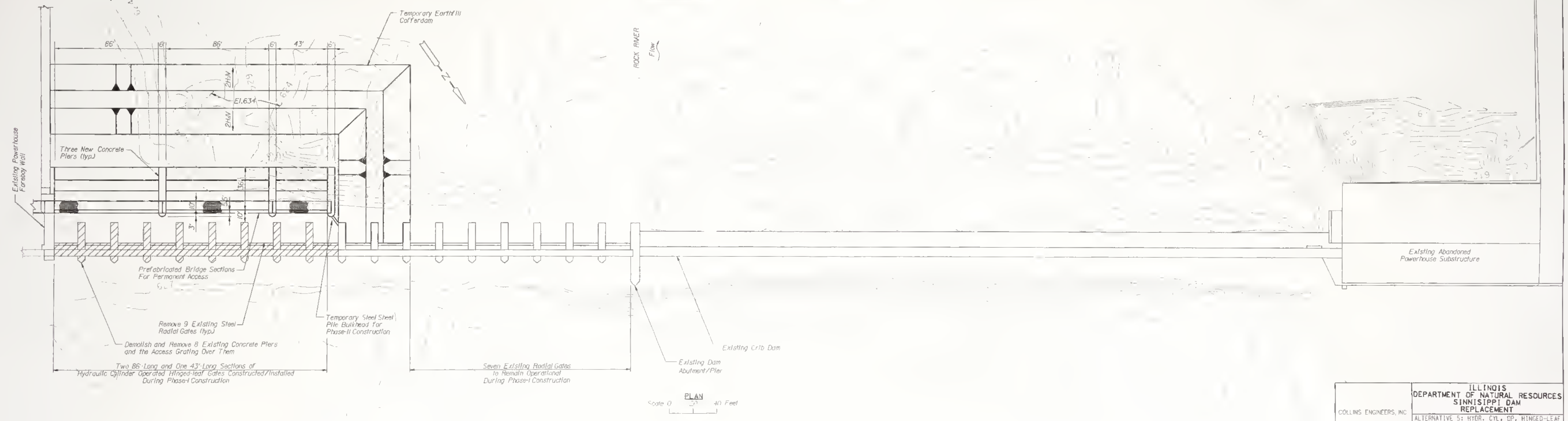
PHASE-I CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 14

9/13/95 PRH

17310047


Temporary Earthfill Cofferdam
ROCK RIVER
Flow
N
86'
6'
86'
6'
43'
6'
2H:N
El.634
2H:N
629
624
Existing Powerhouse Forebay Wall
Three New Concrete Piers (typ.)
36'
10'
5.5'
10'
3'
Prefabricated Bridge Sections For Permanent Access
Remove 9 Existing Steel Radial Gates (typ.)
Demolish and Remove 8 Existing Concrete Piers and the Access Grating Over Them
Temporary Steel Sheet Pile Bulkhead for Phase-II Construction
Two 86'-Long and One 43'-Long Sections of Hydraulic Cylinder Operated Hinged-leaf Gates Constructed/Installed During Phase-I Construction
Seven Existing Radial Gates to Remain Operational During Phase-I Construction
Existing Dam Abutment/Pier
Existing Crib Dam
Existing Abandoned Powerhouse Substructure
Scale 0 20 40 Feet

PLAN

COLLINS ENGINEERS, INC

165 N CANAL ST

CHICAGO, IL 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 5: HYDR. CYL. OP. HINGED-LEAF
GATES W/ CONVENTIONAL CONC.
SPILL. W/O REMOVING EXISTING P.H.

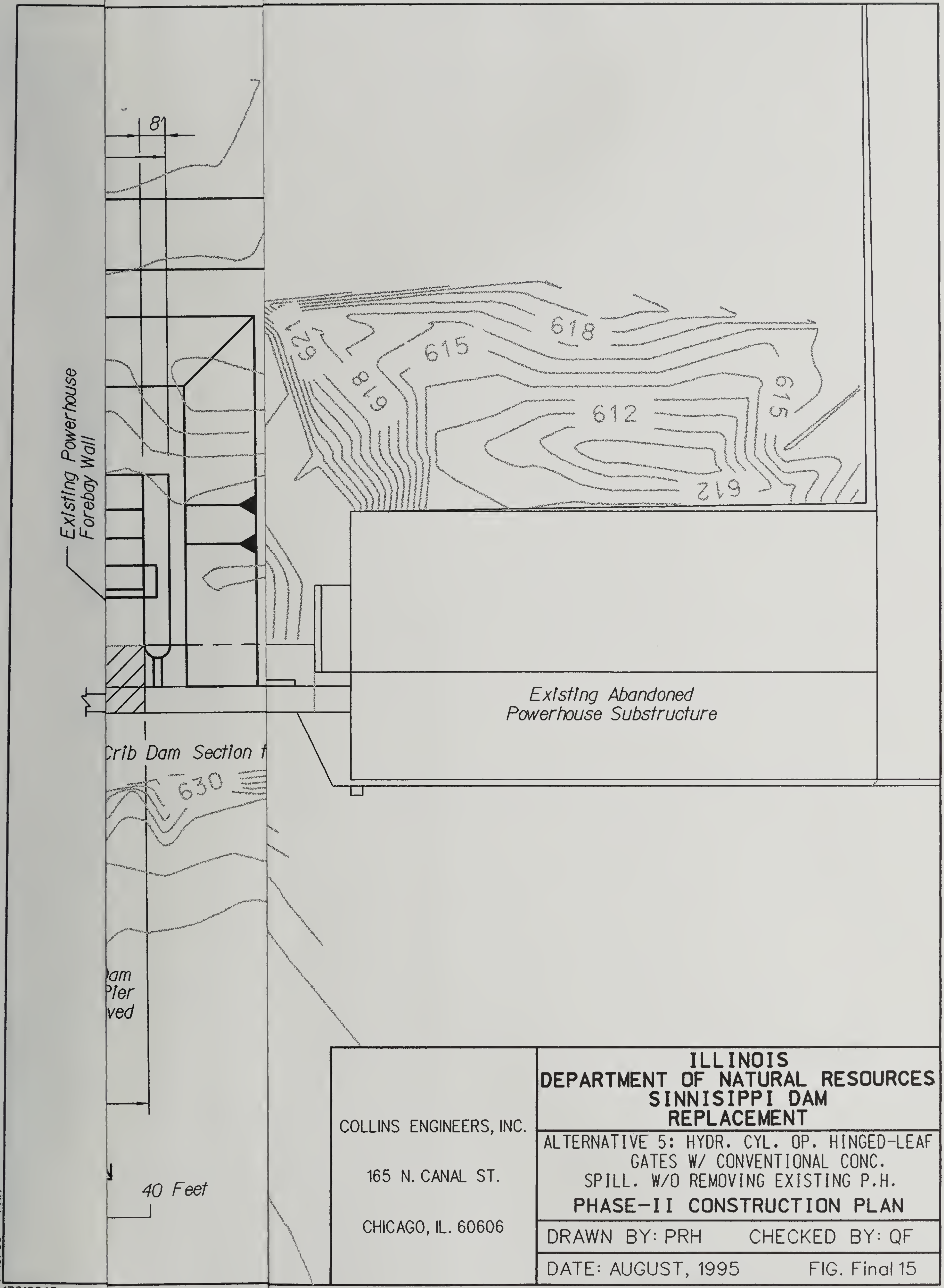
PHASE-I CONSTRUCTION PLAN

DRAWN BY PRH CHECKED BY QF

DATE AUGUST, 1995 FIG Final14

9/12/95 PRH

1731004


8'
Existing Powerhouse Forebay Wall
618
615
618
612
615
612
Existing Abandoned Powerhouse Substructure
Crib Dam Section f
630
Dam
Pier
ved
40 Feet

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 5: HYDR. CYL. OP. HINGED-LEAF
GATES W/ CONVENTIONAL CONC.
SPILL. W/O REMOVING EXISTING P.H.

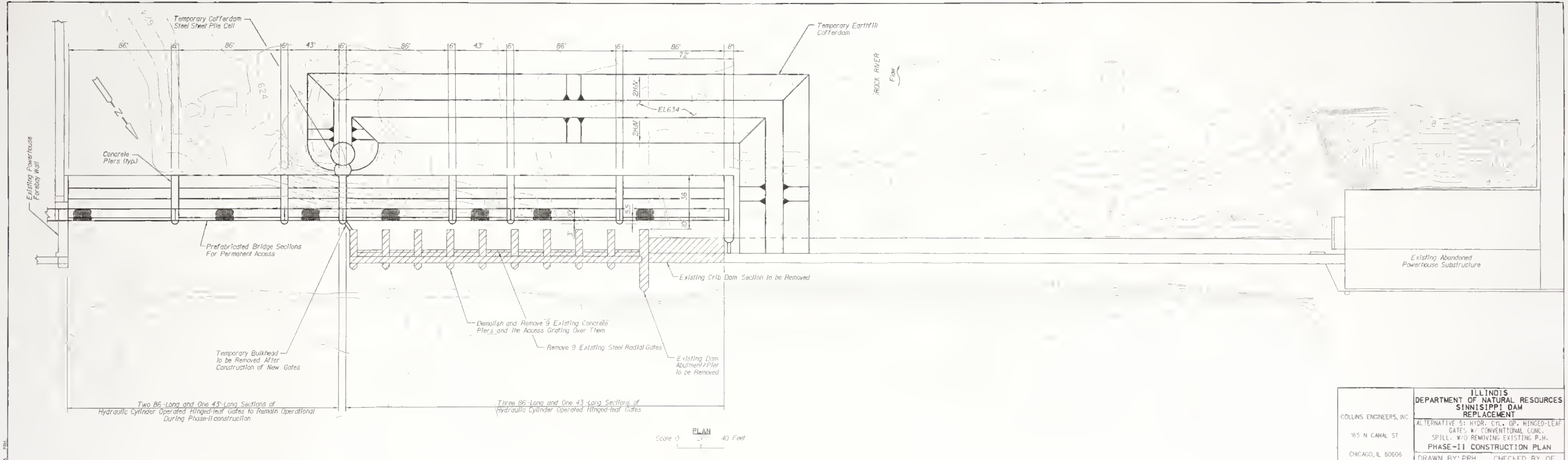
PHASE-II CONSTRUCTION PLAN

DRAWN BY: PRH
CHECKED BY: QF

DATE: AUGUST, 1995
FIG. Final 15

9/13/95 PRH

17310048


Temporary Cofferdam Steel Sheet Pile Cell
Temporary Earthfill Cofferdam
ROCK RIVER
Flow
86'
6'
86'
6'
43'
6'
86'
6'
43'
6'
86'
6'
86'
72'
8'
624
N
2H:1V
El.634
2H:1V
Concrete Piers (typ.)
Existing Powerhouse Forebay Wall
36
5.5
10'
10
3'
Prefabricated Bridge Sections For Permanent Access
Existing Crib Dam Section to be Removed
Existing Abandoned Powerhouse Substructure
Demolish and Remove 9 Existing Concrete Piers and the Access Grating Over Them
Remove 9 Existing Steel Radial Gates
Existing Dam Abutment/Pier to be Removed
Temporary Bulkhead to be Removed After Construction of New Gates
Two 86'-Long and One 43'-Long Sections of Hydraulic Cylinder Operated Hinged-leaf Gates to Remain Operational During Phase-II construction
Three 86'-Long and One 43'-Long Sections of Hydraulic Cylinder Operated Hinged-leaf Gates
PLAN
Scale 0 20 40 Feet

COLLINS ENGINEERS, INC

165 N CANAL ST

CHICAGO, IL 60606

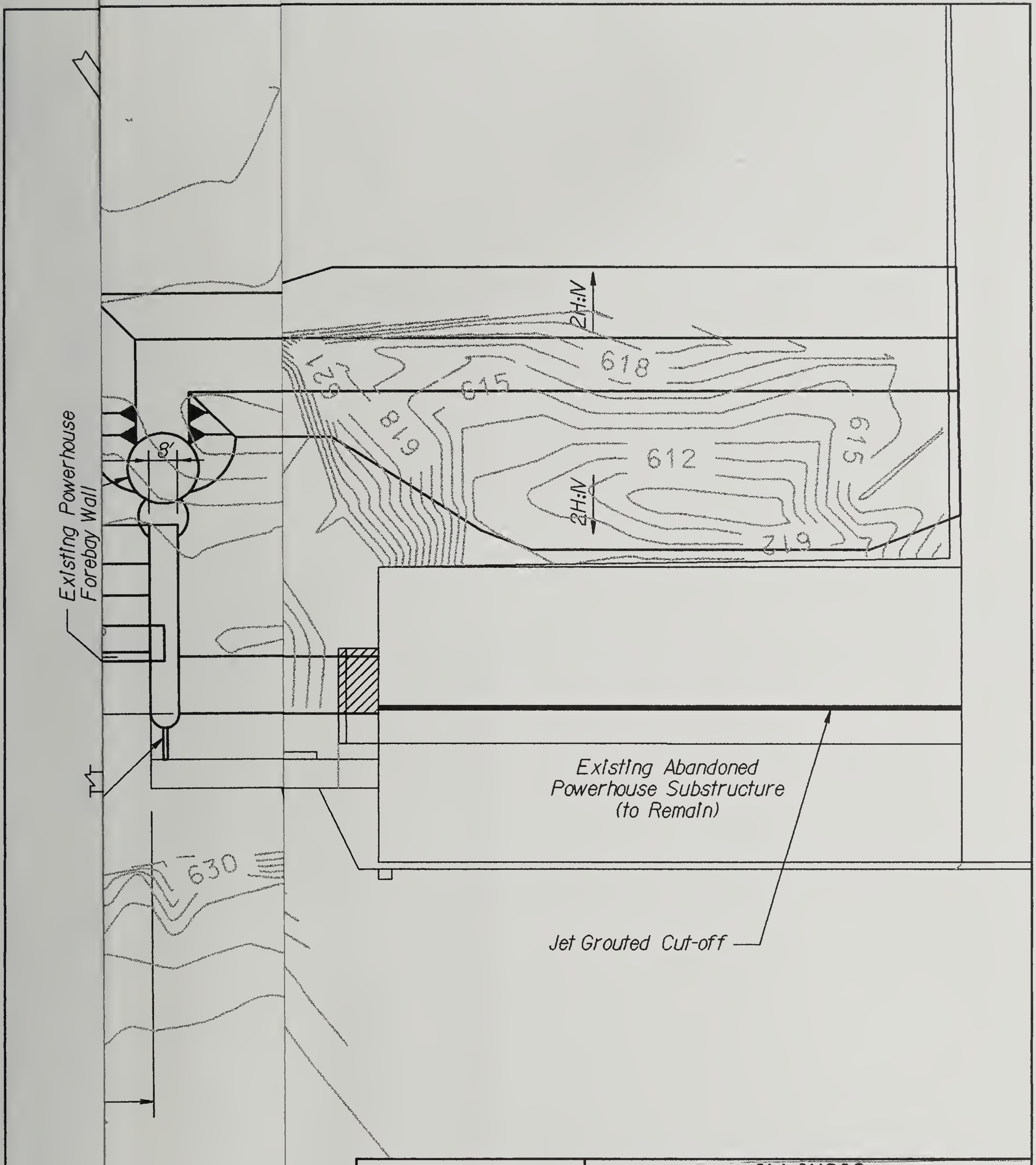
ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 5: HYDR. CYL. OP. HINGED-LEAF
GATES W/ CONVENTIONAL CONC.
SPILL. W/O REMOVING EXISTING P.H.

PHASE-II CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY OF

DATE AUGUST, 1995 FIG Final 15


Existing Powerhouse Forebay Wall
8'
2H:1V
618
615
612
615
618
612
2H:1V
612
630
Existing Abandoned Powerhouse Substructure (to Remain)
Jet Grouted Cut-off
40 Feet

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 5: HYDR. CYL. OP. HINGED-LEAF
GATES W/ CONVENTIONAL CONC.
SPILL. W/O REMOVING EXISTING P.H.

PHASE-III CONSTRUCTION PLAN

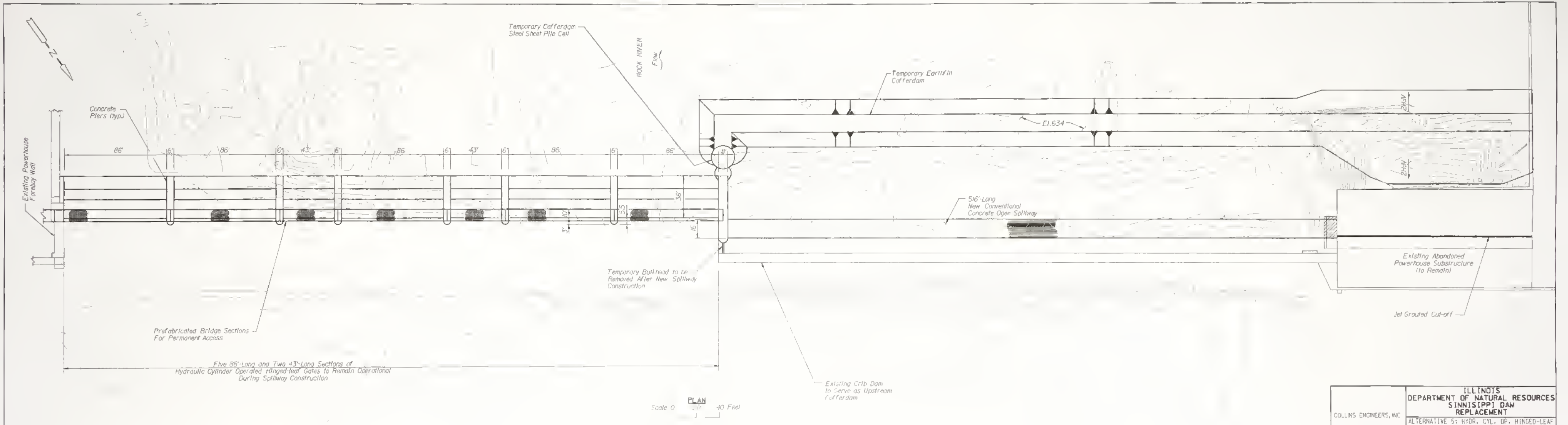
DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 16

9/14/95 PRH

17310049

16


N
Temporary Cofferdam Steel Sheet Pile Cell
ROCK RIVER
Flow
Concrete Piers (typ.)
Existing Powerhouse Forebay Wall
86'
6'
86'
6'
43'
6'
86
6'
43'
6'
86'
6'
86'
8'
36'
5.5
10'
3'
16
Temporary Earthfill Cofferdam
El.634
2H:1V
2H:1V
516'-Long New Conventional Concrete Ogee Spillway
Existing Abandoned Powerhouse Substructure (to Remain)
Jet Grouted Cut-off
Temporary Bulkhead to be Removed After New Spillway Construction
Prefabricated Bridge Sections For Permanent Access
Five 86'-Long and Two 43'-Long Sections of Hydraulic Cylinder Operated Hinged-leaf Gates to Remain Operational During Spillway Construction
Existing Crib Dam to Serve as Upstream Cofferdam
PLAN
Scale 0 20 40 Feet

COLLINS ENGINEERS, INC
165 N CANAL ST
CHICAGO, IL 60606

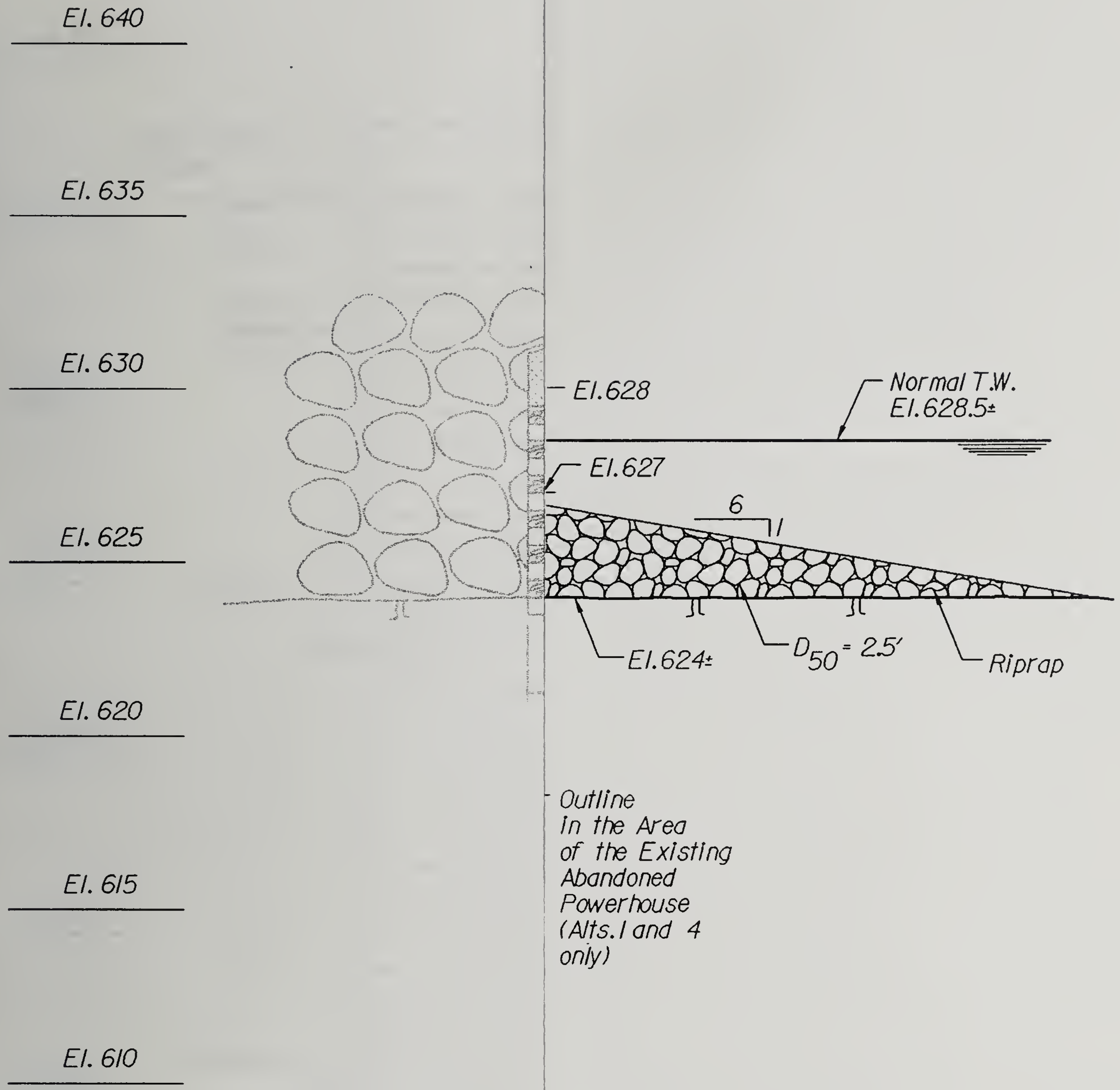
ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVE 5: HYDR. CYL. OP. HINGED-LEAF
GATES W/ CONVENTIONAL CONC.
SPILL. W/O REMOVING EXISTING P.H.
PHASE-III CONSTRUCTION PLAN

DRAWN BY: PRH CHECKED BY OF

DATE AUGUST, 1995 FIG Final 16

17310049



Note:
Existing stru
obtained from
to the Feasib
for Sinnissip
Woodward-Cly
January 1992.

ERS, INC.

L ST.

60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 1, 2, 4 AND 5:

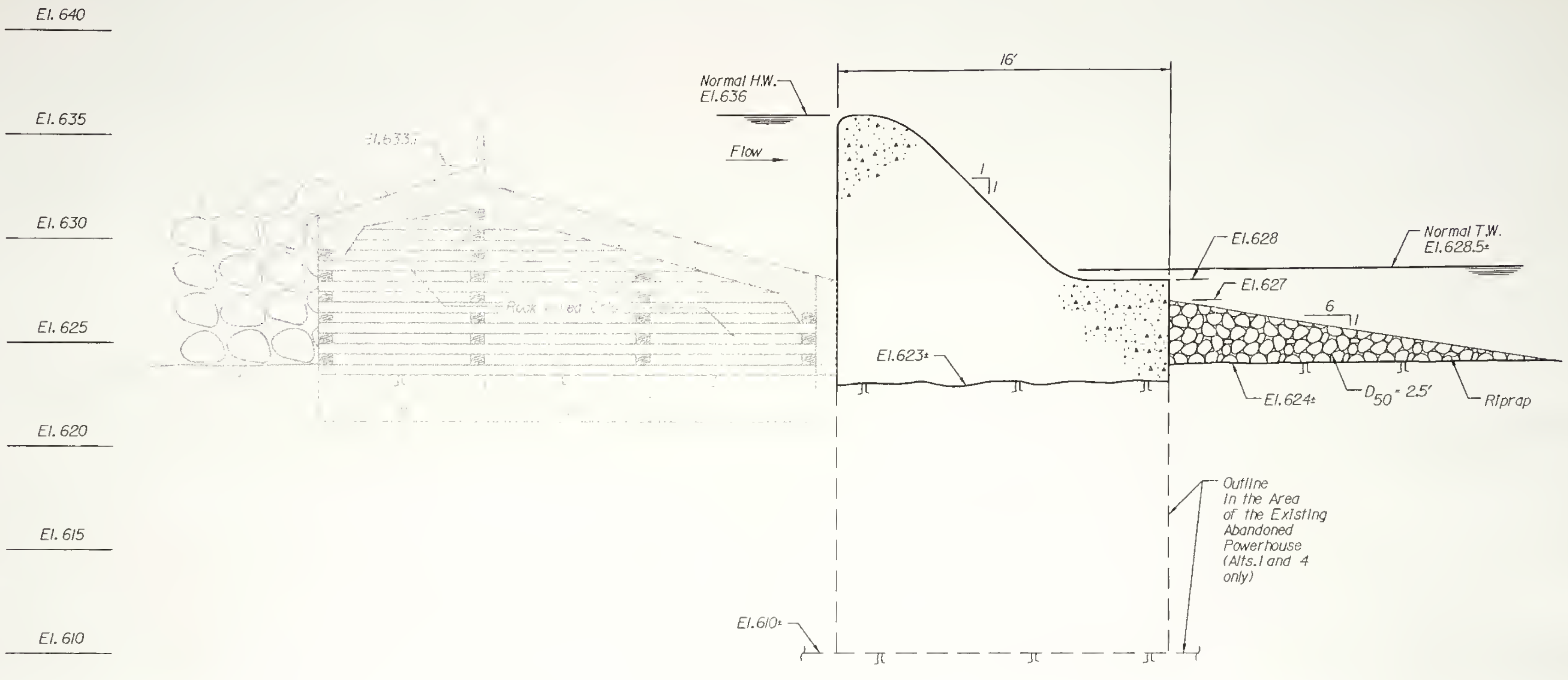
CONVENTIONAL CONCRETE SPILLWAY
CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 17

9/13/95 PRH

17310051



CROSS SECTION

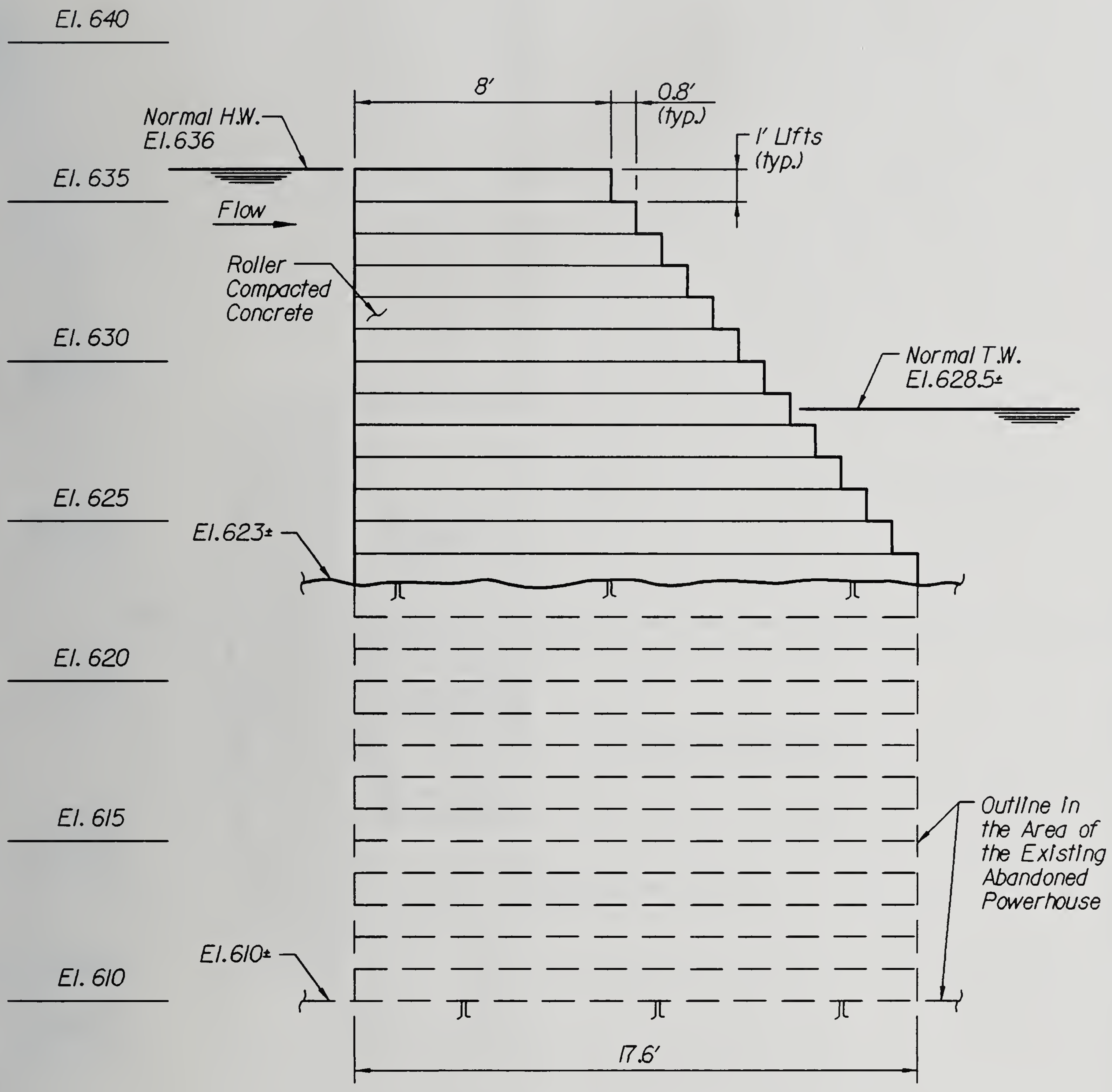
Scale 0 2.5 5 Feet

Note:
Existing structure geometry obtained from the "Addendum to the Feasibility Study Report for Sinnissippi Dam" by Woodward-Clyde Consultants, Inc., January 1992.

COLLINS ENGINEERS, INC. 165 N. CANAL ST. CHICAGO, IL. 60606	ILLINOIS DEPARTMENT OF NATURAL RESOURCES SINNISIPPI DAM REPLACEMENT
	ALTERNATIVES 1, 2, 4 AND 5: CONVENTIONAL CONCRETE SPILLWAY CROSS-SECTION
	DRAWN BY: PRH CHECKED BY: QF
	DATE: AUGUST, 1995 FIG. Final 17

9/13/95 PRH

17310051



CROSS SECTION

Scale 0 2.5 5 Feet

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CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 3 AND 6:

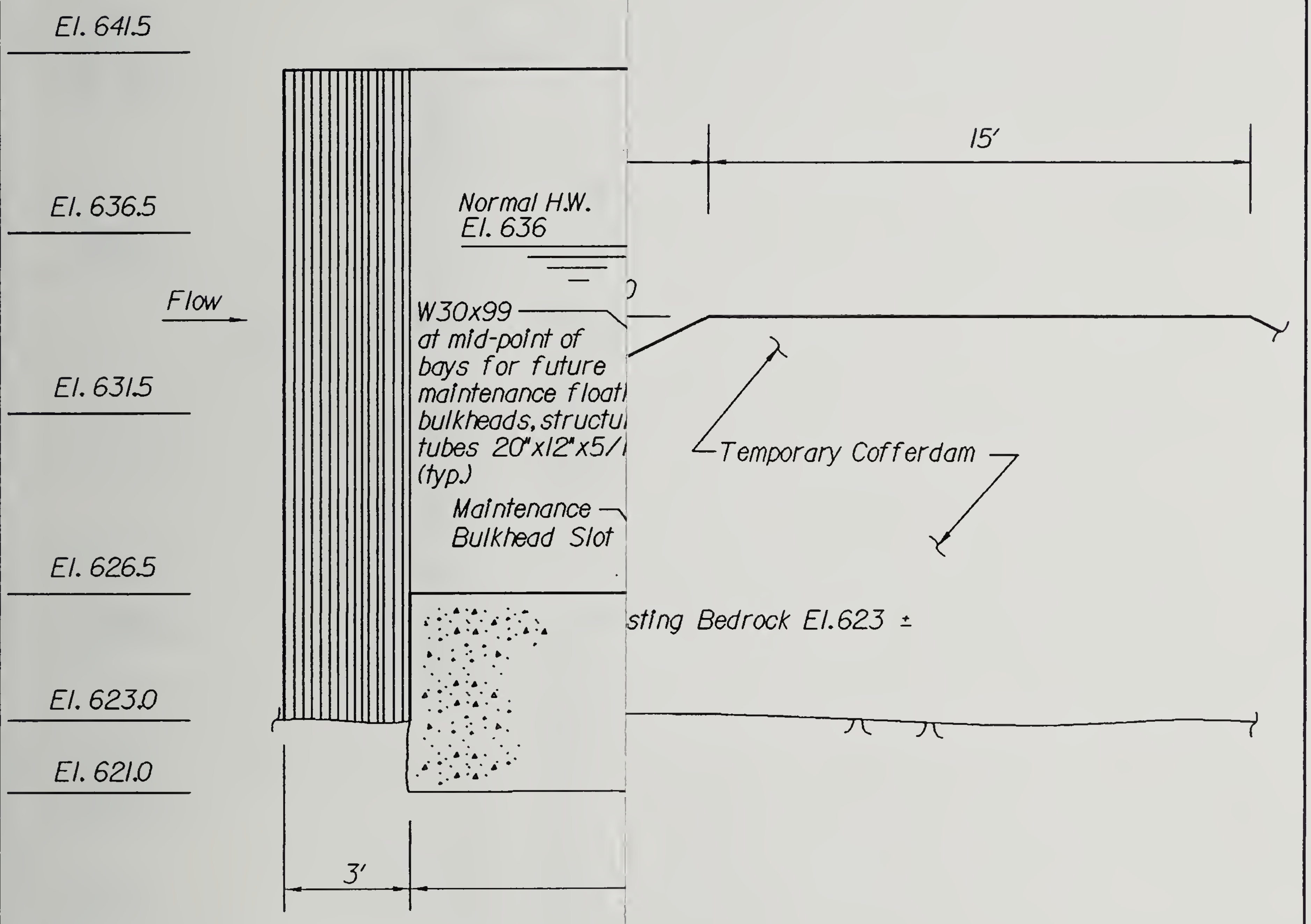
ROLLER COMPACTED CONCRETE SPILLWAY CROSS SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 18

9/13/95 PRH

17310050



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60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

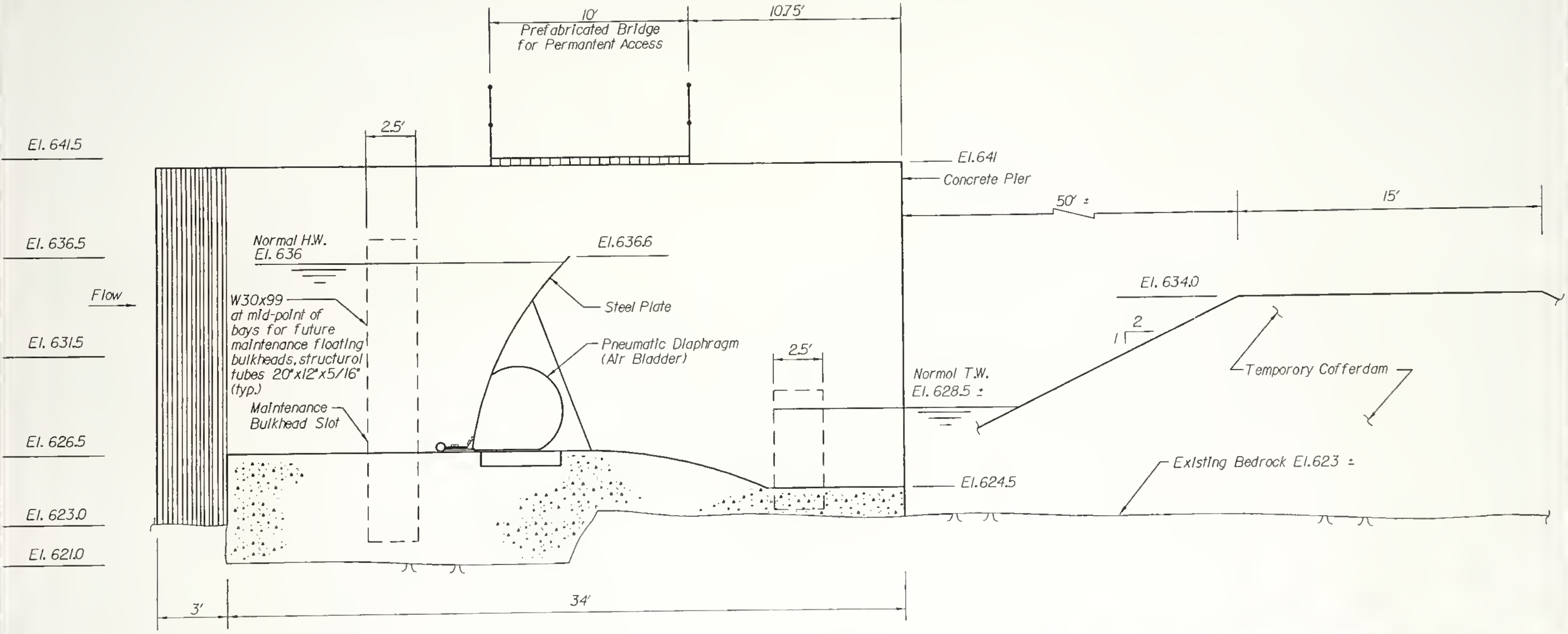
ALTERNATIVES 1, 2 AND 3:
PNEUMATICALLY OPERATED
HINGED-LEAF GATES
CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 19

9/14/95 PRH

17310052


10'
Prefabricated Bridge for Permantent Access
10.75'
2.5'
El. 641.5
El. 641
Concrete Pier
50' ±
15'
El. 636.5
Normal H.W. El. 636
El. 636.6
Flow
Steel Plate
El. 634.0
2
1
El. 631.5
W30x99 at mid-point of bays for future maintenance floating bulkheads, structural tubes 20"x12"x5/16" (typ.)
Pneumatic Diaphragm (Air Bladder)
2.5'
Temporary Cofferdam
Normal T.W. El. 628.5 ±
Maintenance Bulkhead Slot
El. 626.5
Existing Bedrock El. 623 ±
El. 624.5
El. 623.0
El. 621.0
3'
34'

CROSS SECTION

Scale 0 2.5 5 Feet

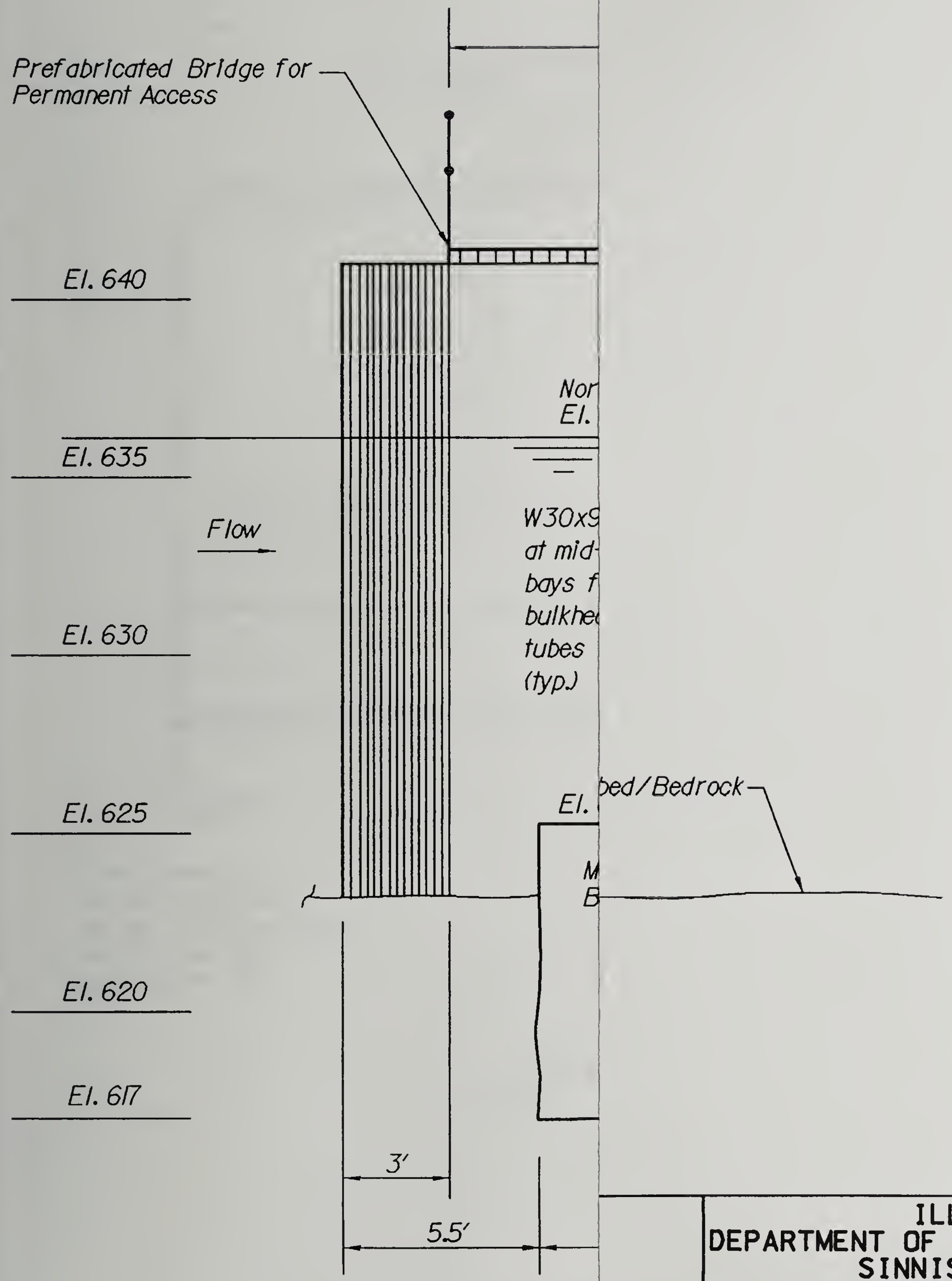
COLLINS ENGINEERS, INC.
165 N. CANAL ST.
CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 1, 2 AND 3:
PNEUMATICALLY OPERATED
HINGED-LEAF GATES
CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF
DATE: AUGUST, 1995 FIG. Final 19

9/14/95 PRH
17310052



ERS, INC.

ST.

60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 4, 5 AND 6:

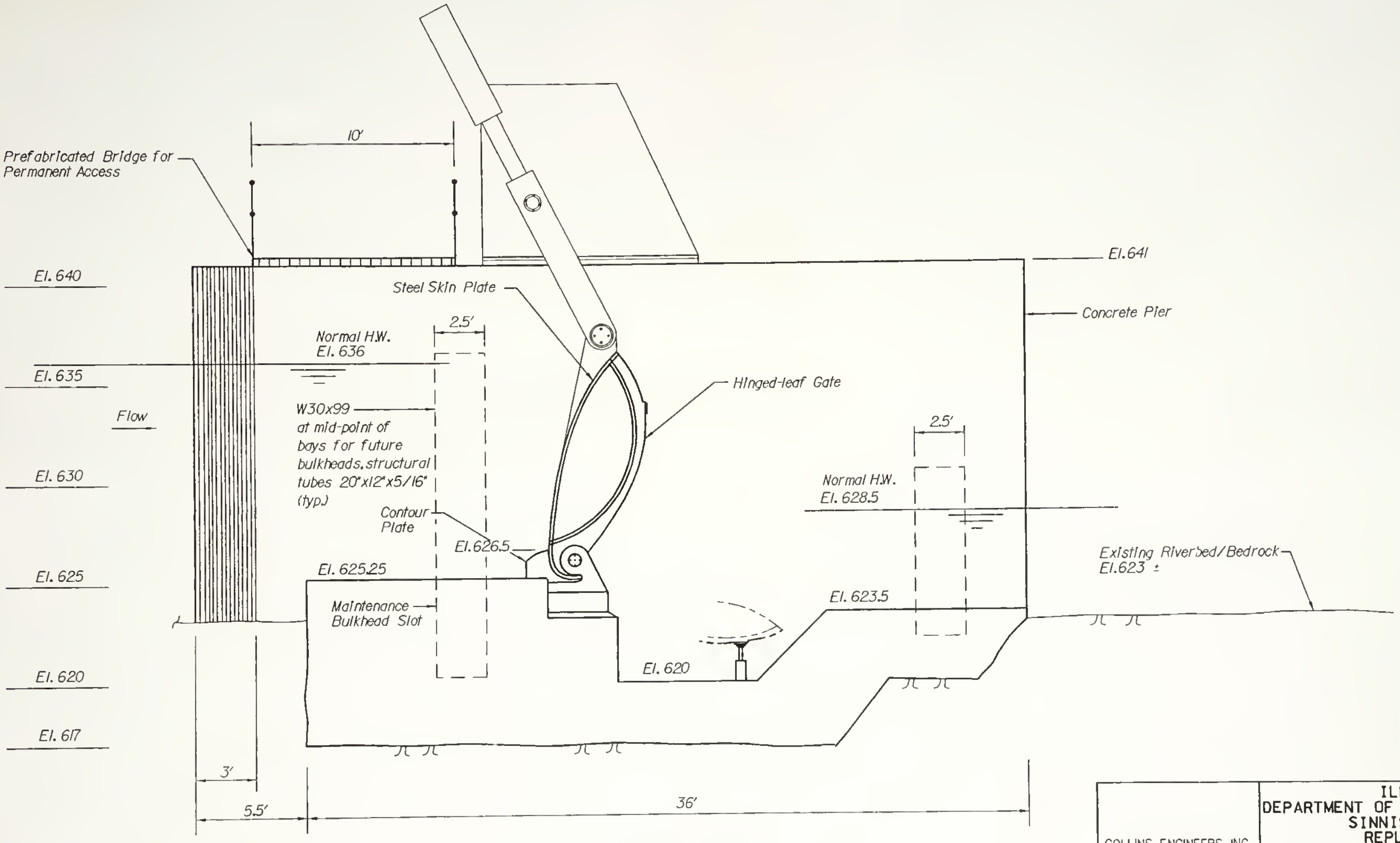
HYDRAULIC CYLINDER OPERATED
HINGED-LEAF GATES
CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 20

9/14/95 PRH

17310053



CROSS SECTION

Scale 0 2.5 5 Feet

COLLINS ENGINEERS, INC.

165 N. CANAL ST.

CHICAGO, IL. 60606

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALTERNATIVES 4, 5 AND 6:

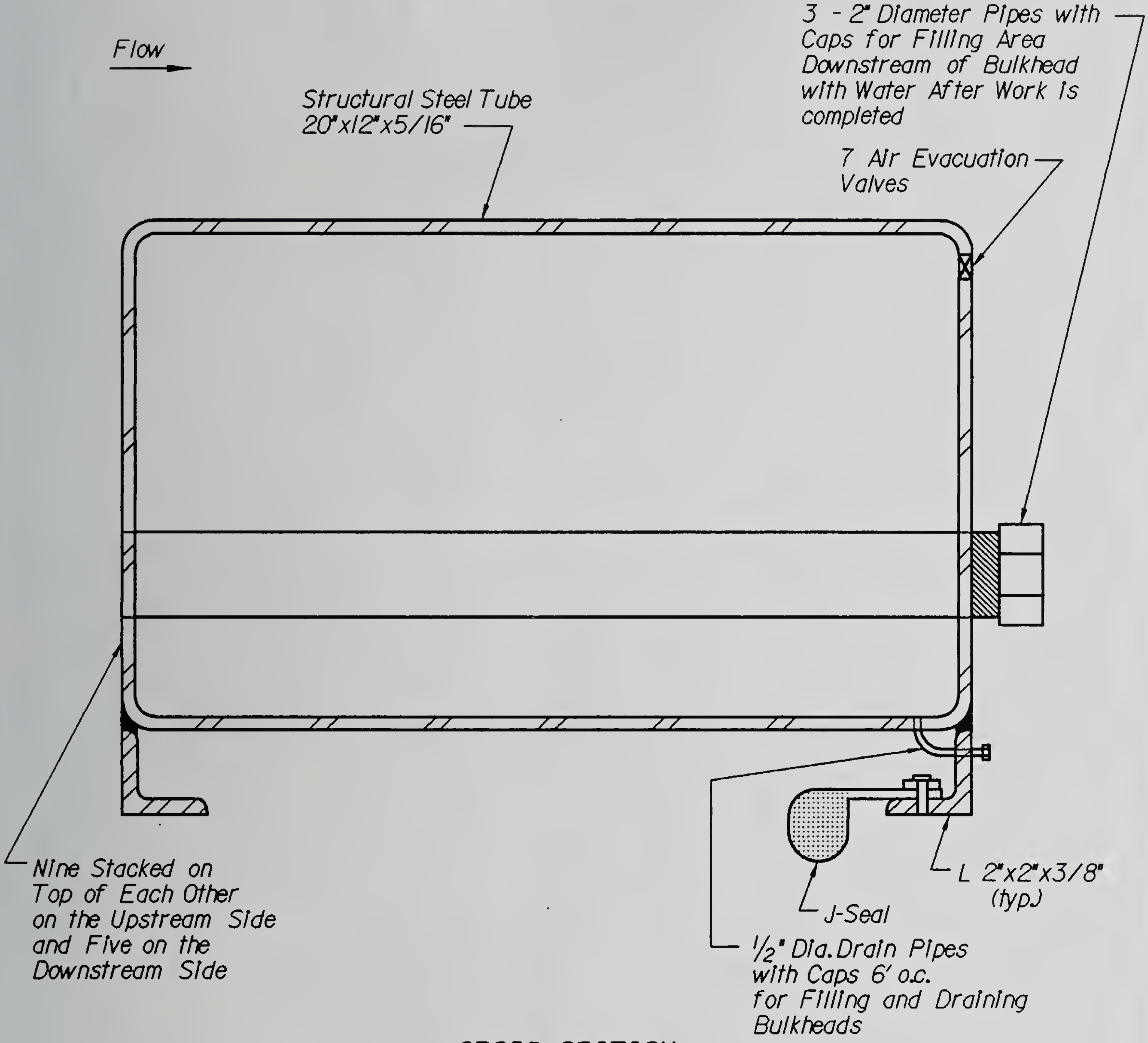
HYDRAULIC CYLINDER OPERATED
HINGED-LEAF GATES
CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 20

9/14/95 PRH

17310053


Flow
Structural Steel Tube 20"x12"x5/16"
3 - 2" Diameter Pipes with Caps for Filling Area Downstream of Bulkhead with Water After Work is completed
7 Air Evacuation Valves
Nine Stacked on Top of Each Other on the Upstream Side and Five on the Downstream Side
J-Seal
L 2"x2"x3/8" (typ.)
½" Dia. Drain Pipes with Caps 6' o.c. for Filling and Draining Bulkheads

CROSS SECTION

Scale 0 2 4 Inches

COLLINS ENGINEERS, INC.

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ILLINOIS
DEPARTMENT OF NATURAL RESOURCES
SINNISIPPI DAM
REPLACEMENT

ALL ALTERNATIVES

FOOTING BULKHEAD
CROSS-SECTION

DRAWN BY: PRH CHECKED BY: QF

DATE: AUGUST, 1995 FIG. Final 21

10/13/95 PRH

17310054

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